Social Cost Benefit Analysis for Environmental Policy Making

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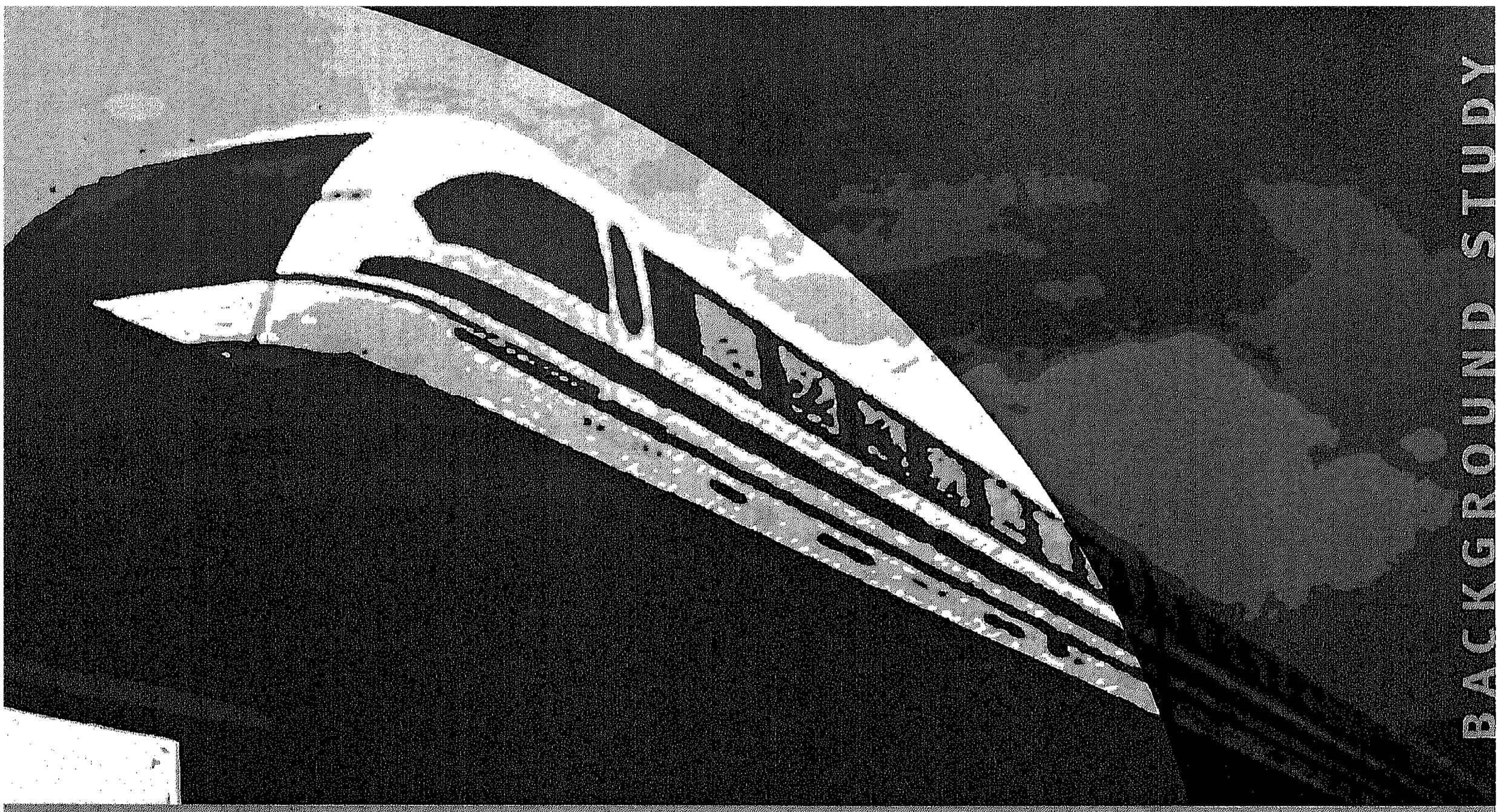

Social Cost Benefit Analysis for Environmental Policy Making

Advisory Council for Research on
Spatial Planning, Nature and the Environment

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Social Cost Benefit Analysis for Environmental Policy Making

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Background study

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Foreword

For some time now Professor Nicholas Stern tours the world with presentations of the *Stern Review*. In the beginning the review was presented as a cost-benefit analysis. Stern argued that it was simply cheaper to act now than to wait and accept the risk of considerable future damage. Cambridge University Press uses a quote from the Daily Telegraph in their marketing activities for the book on the *Stern Review*: "Nicholas Stern has put a price tag on saving the planet". The critique was enormous and concentrated on two points. First, how can we produce serious numbers and make serious valuations of the future damages that we perceive? Second, in connecting current costs and future benefits, the *Stern Review* uses discount rates that are far too low and therefore produces the wrong picture. In subsequent presentations, Professor Nicholas Stern responded by a careful argumentation for the choice of the discount rate and by showing results of a sensitivity analysis, but the critique continued. In recent presentations, he has changed his strategy dramatically. Only two numbers are presented. At the cost of 1% GDP we can lower the chance of a temperature increase of 5 degrees from 47% to 3%. If we then understand that a temperature increase of 5 degrees turns Europe, for example, into a swamp, the trade-off is not hard to make according to prof. Stern. We should be willing to give up 1% GDP to lower the change that something like that will happen.

This story is interesting for a number of reasons. It is clear that prof. Stern changed his strategy because he wanted to focus attention again on the climate change issue and not on the controversies regarding discount rates and monetary valuations of all sorts of possible future damages. The question is, however, if his presentations had had the same effect if they had not been preceded by presentations on a full cost-benefit analysis. Furthermore, the threat ahead may be simple and convincing enough to guide the trade-off, but less obvious issues may be harder to sell. It also boils down now to just his own implicit valuation when he attaches a lower value to giving up 1% GDP than to reducing the change of a 5 degree temperature increase from 47% to 3%. The possible discussion on what is better may be guided by more insight in the cost and benefits and in the way we should discount the future costs and benefits. It is true, however, that this discussion is only fruitful and stays focused on the issue if we have more consensus on valuation and discounting in general. This report presents a state-of-the art in an attempt to reach more consensus on the methodology. Furthermore, it is argued that cost-benefit analyses should be developed in close cooperation with all the stakeholders in order to build more consensus on the results.

There is a lot of discussion and debate going on in academic literature and in society about the topics of valuation, discounting and the rol of SCBA's in environmental policy making. Therfore this report can not give final answers and final solutions for the implementation of SCBAs in environmental policy making. But we do hope that this report will be a fruitfull contribution to the debates between the different scientific disciplines finally leading to more consensus on these issues.

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PART A. REPORT ON SOCIAL COST BENEFIT ANALYSIS FOR ENVIRONMENTAL POLICY MAKING

Nederlandse Management Samenvatting (Dutch executive summary)

Inleiding

De Nederlandse overheid maakt in toenemende mate gebruik van het instrument Maatschappelijke kosten-batenanalyse. Met name voor infrastructurele projecten bestaat er inmiddels een praktische handleiding. Het is echter aannemelijk dat deze handleiding enige aanpassing behoeft op het moment dat milieuaspecten centraal komen te staan in de kosten-batenanalyse. Om die reden is door het Ministerie van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer aan CE gevraagd een praktische handleiding te ontwikkelen voor Maatschappelijke kosten-batenanalyses in het milieubeleid. Verder is aan de RMNO gevraagd om een theoretische achtergrondstudie uit te voeren naar een drietal specifieke vraagstukken, die van essentieel belang worden geacht omdat zij – gezien de wijze waarop zij in een maatschappelijke kosten-batenanalyse worden behandeld – een grote impact hebben op de uitkomsten van de analyse. Om die reden zijn zij van grote invloed op het maatschappelijke en politieke debat naar aanleiding van de uitkomsten en op de feitelijke politieke besluitvorming. Deze drie specifieke vraagstukken zijn:

- Hoe kunnen milieugoederen en –diensten worden gewaardeerd?
- Hoe kunnen toekomstige baten en huidige lasten respectievelijk huidige lasten en kosten in de toekomst worden gewogen (het disconteringsvraagstuk), en hoe moeten waarden worden aangepast voor risico's en onzekerheid?
- Hoe kunnen maatschappelijke kosten-batenanalyses beter worden geïntegreerd in beleidsprocessen en processen van besluitvorming?

Om een antwoord te geven op deze fundamentele vragen is door de RMNO een studie uitgevoerd op basis van het huidige debat en de recente literatuur. De voorlopige conclusies van deze studie zijn becommentarieerd door Professor dr. Michael Hoel van de universiteit van Oslo, Tom Jones van de OECD en Professor dr. David Ulph van de universiteit van St. Andrews . Daarnaast zijn de voorlopige conclusies gepresenteerd op een internationale werkconferentie gehouden in januari 2008 in Den Haag. De conferentie werd georganiseerd m.m.v. het Ministerie van VROM en het Europees Milieuagentschap EEA. De commentaren zijn vervolgens verwerkt in de definitieve versie van de studie.

Met deze studie beogen we vooral te voorzien in een theoretische achtergrond met betrekking tot deze vraagstukken voor beleidsmakers en politici. Daarnaast wille wij een handreiking bieden en enige suggesties doen voor de verdere implementatie van maatschappelijke kosten-batenanalyses in het milieubeleid.

De waardering van milieugoederen en –diensten

In maatschappelijke kosten-batenanalyses zijn prijzen nodig om huidige en toekomstige kosten en baten te kunnen uitdrukken in monetaire waarden. Voorzover milieugoederen en -diensten op een markt worden verhandeld en er marktprijzen voorhanden zijn is er geen probleem. Vaak zullen echter geen marktprijzen voor dit type goederen en diensten voorhanden zijn en in die situaties zullen we prijzen moeten construeren wanneer we de maatschappelijke

kosten en baten echt in monetaire waarden willen uitdrukken om ze vervolgens te kunnen vergelijken met andere maatschappelijke kosten en baten in besluitvormingsprocessen. Over de vraag of we altijd moeten proberen om een monetaire waarde te construeren voor alle milieugoederen en –milieudiensten, daarover lopen de meningen sterk uiteen, maar wanneer we eenmaal de beslissing hebben genomen om een waarde voor deze goederen en diensten te construeren dan zijn er verscheidene methoden beschikbaar.

'Revealed preference'-methoden worden veelvuldig toegepast en worden als redelijk betrouwbaar aangemerkt als het gaat om het schatten van de ondergrenzen van de waarden die mensen toekennen aan publieke goederen zoals de kwaliteit van het milieu. Voorbeelden van deze methoden zijn onder meer de hedonistische prijsmethode (HPM), de reiskostenmethode en de 'averting behaviour'-methode (ABM). Deze methoden kunnen echter niet in iedere situatie gebruikt worden. Bijvoorbeeld als het gaat om de bepaling van de waarde van milieugoederen en –diensten die niet gebruikt worden zijn andere methoden vereist.

'Stated preference' –methoden zoals bijvoorbeeld de 'Contingent Valuation'-methode worden veelvuldig bekritiseerd in de literatuur. Deze methoden kennen vele methodologische problemen, maar desondanks worden deze methoden regelmatig toegepast voor zowel wetenschappelijke doeleinden als beleidsdoeleinden en deze methoden worden nog steeds verder verbeterd. Voor de bepaling van sommige waarden is de 'Contingent Valuation'-methode zelfs de enige methode die bruikbaar is om maatschappelijke kosten en baten in monetaire waarden uit te drukken. Daarom kan deze methode ondanks haar zwakke methodologische punten (biases) niet zo maar terzijde worden geschoven. Hoewel de methode meer en meer wordt aanvaardt in sommige wetenschappelijke disciplines (bijvoorbeeld de economische discipline) en sommige beleidskringen, zal er altijd sprake zijn van discussie en debat omdat blijven tegenstanders van een bepaald beleid of bepaalde beleidsbeslissingen de methode zullen blijven aanvallen op haar zwakke methodologische punten bij de constructie van waarden voor milieugoederen en –diensten. Om die laatste reden is het van groot belang dat de toegepaste methode state- of the art is en dat zwakke punten zoveel mogelijk transparant worden gemaakt, hoewel dat de problemen niet geheel zal wegnemen. Tegenstanders zullen immers altijd argumenten naar voren blijven brengen die te maken hebben met de constructie van monetaire waarden of met waarden en normen in het algemeen zoals bijvoorbeeld 'kunnen we werkelijk een waarde toekennen aan biodiversiteit' of 'moeten we onze planeet dan maar opofferen om economische redenen en winsten'. Onze uiteindelijke conclusie is dus dat er methoden beschikbaar zijn om monetaire waarden te construeren ook als het gaat om milieugoederen en –diensten zo dat alternatieven in monetaire waarden tegen elkaar kunnen worden afgewogen en zwakke punten transparant kunnen worden gemaakt, maar dat het debat tussen voor- en tegenstanders niet zal verstommen. Uiteindelijk zal de beslissing altijd een politieke beslissing zijn.

Tenslotte moet als duidelijk minpunt van waarderingsstudies worden vermeld dat deze nogal tijdrovend en kostbaar zijn en dat zij ook specifiek en locatiegebonden zijn. De mate waarin resultaten van studies verkregen in een specifieke regio of situatie ook generaliseerbaar zijn en toepasbaar in andere regio's of situaties is nog onderwerp van debat.

Het vraagstuk van discontering en correctiefactoren voor risico's en onzekerheid

In de economische wetenschappen wordt discontering toegepast om de tijdvoorkeur tot uitdrukking te brengen. We hebben liever vandaag de beschikking over materiele goederen of over diensten dan over bijvoorbeeld vijf of twintig jaar. Er is echter in de literatuur veel discussie en debat over de vraag of we de zelfde discontovoet kunnen gebruiken voor geconstrueerde milieukosten en -baten van goederen en diensten van het ecologisch systeem als voor geld of materiele goederen en diensten verhandeld via of aangeboden op de markt.

Het debat op dit punt is nog zeker niet uitgekristalliseerd en er is geen consensus over de feitelijke discontovoet die we moeten hanteren in kosten-batenanalyses waarbij milieukosten en milieudiensten een substantiële rol spelen. Milieu-issues hebben een grote impact en er is veel discussie tussen de verschillende actoren over hoe nu eigenlijk met milieuvraagstukken om te gaan bij het uitvoeren van kosten-batenanalyses.

Hoewel er geen definitieve overeenstemming is over de feitelijk te hanteren discontovoet is er wel enige consensus over het feit dat het simpelweg gebruiken van de marktrente, de discontovoet die gehanteerd wordt voor consumenten of de interne rentevoet die bedrijven hanteren, als discontovoet voor maatschappelijke kosten-batenanalyses te eenvoudig en niet correct is. Een lagere of zelfs een afnemende discontovoet in de tijd lijkt meer geëigend en aanvaardbaar voor de meeste betrokken actoren. Des te onzekerder de staat van de economie in de (verre) toekomst, des te meer een samenleving zou moeten sparen en des te lager de discontovoet. Discussie en debat op dit punt worden dus voortgezet ook omdat dit vraagstuk meer een politiek en/of ethisch karakter heeft dan een technisch economisch . Daarom vragen wij ons ook af of het veel zin heeft om nog veel langer te blijven discussiëren en debatteren over de discontovoet. Wij neigen er naar om die vraag ontkennend te beantwoorden, omdat de impact van het hanteren van verschillende discontovoeten op het resultaat van de kosten-batenanalyse op eenvoudige wijze door middel van een gevoeligheidsanalyse duidelijk en transparant kan worden gemaakt. Het laten zien van de verschillende uitkomsten voor verschillende discontovoeten laat ruimte voor discussie en debat tussen politici en in de samenleving en daar moet uiteindelijk ook de keuze worden gemaakt en de besluitvorming plaatsvinden. Het economische raamwerk is maar één van de mogelijk geschikte raamwerken dat kan worden gebruikt in de discussie over milieuvraagstukken en het milieubeleid.

De rol van maatschappelijke kosten-batenanalyses in de besluitvorming over het milieubeleid

De keuze voor een maatschappelijke kosten-batenanalyse dan wel voor andere instrumenten

De maatschappelijke kosten-batenanalyse is maar één van de mogelijke instrumenten die kunnen worden gebruikt om informatie te verzamelen en te structureren ten behoeve van besluitvormingsprocessen. In een maatschappelijke kosten-batenanalyse worden een economisch raamwerk en economische uitgangspunten gehanteerd. De keuze voor de maatschappelijke kosten-batenanalyse als instrument zal dus vooral plaatsvinden als er een behoefte is voor het verzamelen en structureren van informatie vanuit een economisch perspectief en wanneer winst en andere economische waarden dominant zijn. Afhankelijk van de specifieke omstandigheden en de gedefinieerde uitgangspunten en waarden kan de keuze ook vallen op andere instrumenten zoals de Multi Criteria Analyse (MCA), het milieu impact assessment, een kosteneffectiviteitsanalyse of bijvoorbeeld 'Choice Modelling'. Een analyse kan derhalve gemaakt worden vanuit verschillende gezichtspunten (bijvoorbeeld een technisch – wetenschappelijk - , een rationeel - , een sociaal-cultureel - , een ecologisch – of een politiek-perspectief) met een breed scala aan mogelijke uitkomsten en mogelijke voorkeursalternatieven met inzet van verschillende methoden en technieken. Het is belangrijk om te onderkennen dat veel van de zogenaamde 'harde' en 'rationele' feiten in de dagelijkse praktijk veelal 'zacht' en waardegebonden zijn en dat de interpretatie van die feiten en de te maken keuzes veelal een ethische en politieke dimensie zullen hebben. Gezien de complexiteit, de noodzakelijke 'joint fact-finding' en de kosten verbonden aan het uitvoeren van een MKBA wordt geadviseerd de toepassing van MKBA te beperken tot de grotere vraagstukken.

Maatschappelijke kosten-batenanalyse als instrument of als proces

Wanneer we een maatschappelijke kosten-batenanalyse willen gebruiken welke rol kan en moet deze dan spelen in het besluitvormingsproces? Is een MKBA niet meer of minder dan een techniek en een instrument ter ondersteuning van de besluitvorming of moeten we een MKBA veel meer opvatten als een geïntegreerd onderdeel van het proces van beleidsvorming? Voor investeringsbeslissingen door private ondernemingen kunnen kosten-batenanalyses worden gezien als een methode of instrument voor het structureren van informatie en het zo vergelijkbaar mogelijk maken binnen zekere grenzen. Besluitvorming bij de overheid en zeker ook besluitvorming in het kader van milieubeleid is complexer en vaak is ook sprake van vele actoren en vele omstreden 'issues' en waarden. Voor milieuvraagstukken zijn er vele belangengroepen, het milieu is een publiek goed en de besluitvorming, het milieubeleid en de beleidsmaatregelen zullen veelal een impact hebben over zeer lange perioden of op de zeer lange termijn. Belangengroepen kunnen daarbij geheel verschillende belangen hebben en ook verschillende opvattingen over wat het probleem is, wiens probleem het is en hoe het probleem moet worden opgelost en wiens belangen worden gediend. De uiteindelijke keuze zal veelal een politieke of ethische keuze zijn die moet worden gemaakt en uitgelegd door de politiek.

Om vorengenoemde redenen wordt het proces van het verzamelen en structureren van informatie en het discours over de informatie en de 'feiten' in de kosten-batenanalyse in het kader van besluitvorming over het te voeren milieubeleid uiterst belangrijk. Veel feiten en kennis zal niet eenduidig, onzeker, 'zacht' en waardegeladen zijn. De vraag komt dan centraal te staan welke belangengroepen in het proces moeten worden betrokken, op welke momenten noodzaak. Iedere belanghebbende/ politieke actor zal indien gewenst in staat moeten zijn of worden gesteld de kosten en baten te bepalen op basis van zijn eigen normen en waarden en uitgangspunten indien de gevoeligheidsanalyse – die standaard aanbevolen wordt – hem of haar nog onvoldoende informatie verschaft ter bepaling van zijn standpunt. Een MKBA in het kader van het milieubeleid moet daarom ook eerder worden opgevat als een proces en niet zozeer als de toepassing van een instrument en er dient veel aandacht te zijn voor het betrekken van de juiste belangengroeperingen in het proces, de te hanteren uitgangspunten en veronderstellingen en de uitvoering van de gevoeligheidsanalyse.

Samenvattend: Drie hoofdconclusies over het gebruik van MKBA's in milieubeleid

1. Als in de besluitvorming wordt gekozen voor het maken van een keuze tussen beleidsalternatieven of –scenario's op basis van een afweging tussen (maatschappelijke) kosten en baten, dan kan een MKBA een goede methode zijn. Indien dit niet het geval is, dan zal een keuze moeten worden gemaakt uit alternatieve methoden. Deze afweging is een politieke afweging.
2. Een MKBA in het milieubeleid vereist
   a. dat bij de bepaling van de kosten en baten die in de MKBA in aanmerking worden genomen (dit is een politieke keuze), de kosten en baten van effecten op natuur – en milieu zorgvuldig worden beschouwd en expliciet worden meegenomen;
   b. transparantie over alle veronderstellingen over o.a. de waardering van baten en kosten;
   c. een participatief proces waarbij de belangrijkste stakeholders in de gelegenheid zijn om hun visie op de aannamen te geven;
   d. dat het proces zodanige waarborgen bevat dat de politiek die keuzes en aannames maakt waarvoor zij verantwoordelijk is en dat de vervaardiger van de MKBA de methode integer toepast met in achtneming van de politiek gemaakte keuzes en de door de politiek aangegeven aannames;

e. een investering van voldoende tijd en geld om aan deze condities te kunnen voldoen.

3. Omdat de uitkomst van een MKBA afhangt van de veronderstellingen die in het model worden gestoken, is elke MKBA een uniek product van een politiek verantwoordelijke. De kwaliteit van het politieke debat over beleidsvoornemens kan groter worden indien ook andere stakeholders en bijvoorbeeld de politieke oppositie de gelegenheid krijgen om een alternatieve MKBA te laten uitrekenen op basis van hun eigen veronderstellingen.

Executive Summary

Introduction

In recent years the Dutch government has used SCBAs[1] predominantly for infrastructural projects. A useful practical guide for this type of issues exists. However, it is to be expected that this guide needs some adjustments in case environmental issues are central in the SCBA. So VROM has asked CE to develop practical guidelines for SCBAs in environmental policy and RMNO to address three specific theoretical issues. These three specific issues are supposed to be of major importance because the way in which they are treated in an SCBA will have a large impact on the results and outcome and will be of great influence in the debate afterwards and the actual decision making. The actual questions are: (i)how can environmental goods and services be valued; (ii) how can future benefits and current costs or current benefits and future costs be weighed (this is the issue of discounting), and how should values be adjusted for risk and uncertainty; (iii) how can SCBAs be integrated in the policy and decision making process.

The approach of RMNO to develop an answer to these fundamental questions concentrated on reviewing the theoretical literature and the current debate on these topics. The preliminary conclusions of this review have been reviewed by Professor dr. Michael Hoel of the University of Oslo, Mr. Tom Jones of the OECD and Professor dr. David Ulph of the University of St. Andrews and have also been presented at an International Working Conference in January 2008 in The Hague. The conference was co-hosted by the Ministry of VROM and the European Environment Agency EEA. The comments have been used for the final report.

In this final report we focus on addressing these three questions in order to provide a theoretical background on these issues for policymakers and politicians and a further perspective and some suggestions for the practical implementation of SCBA in environmental policymaking.

The valuation of environmental goods and services

In SCBAs we need prices so we can express current and future costs and benefits in monetary values. If we have market prices, the problem of knowing the costs and benefits in monetary values is less difficult. But in case of environmental goods and services there are often no (market) prices available. Therefore, we have to construct them if we really want to express social costs and benefits in monetary values to make it possible to compare them with other social costs and benefits in processes of decision making. There seems to be no consensus about the question if we should always try to put a monetary value on all environmental goods and services. But if we have made the decision to construct a monetary value for environmental goods and services, there are several valuation methods available. Revealed preference methods are widely applied and are considered reliable in providing lower-bound estimates of people's valuation of public goods such as environmental quality. Examples of these methods are the hedonic pricing method (HPM), the travel cost method (TCM) and the averting behaviour method (ABM). However it is not possible to apply these methods in all situa-

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[1] The term 'social' in 'social cost benefit analysis' is meant to cover all societal issues, not only 'social' issues.

tions and especially for non-use values. Stated preference methods like the Contingent Valuation Method (CVM) are much more criticized in literature. There are many methodological problems, but despite these problems these methods are still being applied for both scientific and policy purposes, and it is being refined over time. For some values the "contingent valuation method" is even the only method to express (social) costs and benefits in monetary values and therefore these methods can not be set aside despite weak methodological points (biases). Although it seems that the method's acceptability in some scientific disciplines (e.g. economics) and policy circles has increased there will be always discussion and debate with opponents attacking the method on the weak methodological points and biases in the construction of these monetary values for environmental goods and services. Therefore it is important that the applied method is the state-of-the-art and weak parts must be made transparent. But transparency will not solve the problem completely. Opponents will always put forward statements as "can we really put a monetary value on biodiversity" or "do we have to give up our planet for economic reasons and profits". So the ultimate conclusion is that there are methods to construct monetary value for environmental goods and services so that options can be weighed in monetary terms and weak points can be made transparent but it isn't likely that the debate between proponents and antagonist will end. In the end the final decision will always be a political decision.

Finally a serious disadvantage of valuation studies is that they are quite expensive and time-consuming to implement and the extent to which benefits obtained in one region (or specific situation) are transferable to other regions (or other situations) is still under debate.

Discounting and the correction of values for risk and uncertainty

In economics discounting is used to express a time-preference. We would like to have material goods and money now in stead of let's say in five, ten or twenty years. There is much discussion and debate if we can use the same discount rate as used for money or material goods and services in economics also for constructed environmental costs and benefits of goods and services of the ecological system. The debate is still going on and there is no consensus about the actual discount rate we should use in cost-benefit analyses in which these environmental costs and services play a substantial role, environmental issues have a great impact and how to handle them causes a lot of discussion between different actors. Although there is no final consensus about an actual discount rate there seems to be some consensus about the fact that using the market interest rate or the consumer discount rate or the firm's internal rate of return as the discount rate for SCBAs is too simple and not correct. A lower or declining discount rate seems to be more appropriate and acceptable for the most actors. The more uncertain the future state of the economy, the more society should save and hence the lower the discount rate. Having said this there is still ample room for debate on this issue, especially because part of the issue is not a technical economic one but an ethical one. Therefore the ultimate question will be does it make sense to debate or argue about discount rates any longer? We tend to say no, because it is easy to show the impact of the choice of different discount rates on the costs and benefits in a cost-benefit analyses in a sensitivity-analyses. Showing the different outcomes for different discount rates will leave room for discussion and debate among politicians and within society and that's where the choice have to be made. The economic framework is just one of the suitable frameworks for the discussion about environmental issues

The role of SCBAs in environmental decision making processes

The choice for a SCBA or for other instruments

SCBA is just one of the possible instruments to gather and structure information in a process of decision making. In a SCBA an economic framework and economic principles are used. So a SCBA will be used as instrument when there is a need for gathering and structuring information from an economic perspective and when profit and other economic values are dominant. However depending on the circumstances and the defined principles and values also other instruments can be used such as Multi Criteria Analysis (MCA), Environmental Impact Assessment, Cost Effectiveness Analysis, or for instance Choice Modelling. So analysis can be made from many different perspective (for instance a technical-scientific and rational perspective, a social-cultural - , an ecological – or a political perspective) with a wide range of possible outcomes and possible 'most' preferred choices. We should realize that many so called 'objective and rational facts' in theory are 'soft' and value-laden in practise and interpretation and choices will have most of the time a ethical and political dimension. Because of the complexity, the necessity of joint fact-finding and the costs of a SCBA it s advised to restrict the application of SCBA to large problems.

SCBA as an instrument or as a process

So when we want to use a SCBA what role (s) should and can it play in the decision making process? Is a SCBA just a tool and a decision support instrument or do we have to consider SCBA as an integrated part of a policy-making process? For investment decisions by private companies (S)CBAs can possibly be seen as a method and instrument for structuring information and making this information as comparable as possible within certain limits. Governmental decisions and certainly decisions about environmental issues are more complex and often there are many actors and many contested issues and values. There is a large 'stakeholder landscape' for environmental issues, the environment is a public good and the decision making and policy measures tend to have a very long term impact. Stakeholders may have very different interests and views on what the problem is, whose problem it is, how the problem should be solved and whose interests are served. The final choice will often be a political and/or ethical choice which have to be made and explained by politicians. Therefore in environmental decision making the process of gathering and structuring information and the discourse about the information and 'facts' in the SCBA becomes much more important. Many facts and knowledge will be soft and value-laden. For that reason a central question will be which stakeholders have to be involved in the process, at which moments and for what reasons and openness and transparency becomes a necessity. It is important that every stakeholder or political actor can perform his or her own SCBA with his or her own parameters and values when the sensitivity-analysis – which is standard recommended – provides him or her insufficient information to make a choice. Therefore a SCBA regarding environmental issues should be seen as a process and much attention should be given to stakeholder involvement in that process, the (normative) assumptions and the sensitivity-analysis.

Drie key conclusions about the use of SCBAs in environmental policy making

1. If in the process of decision making it is decided to choose between policy alternatives or policy scenarios on the basis of weighing (societal) costs and benefits, SCBA can be a good method. If this is not the case, alternative methods must be chosen. This choice is a political choice.

2. An SCBA in environmental policy making requires:
   a. That in the decision about which costs and benefits will be assessed in the SCBA process (a political choice), the costs and benefits of the impacts on nature and the environment carfully and explicitly are taken into account;
   b. Transparency about all assumptions on for example the valuation of costs and benefits;
   c. A participative process in which the most important stakeholders are able to present their vision on the assumptions;
   d. That the process quarantees that politicians make the choices and determines the assumptions for which they are responsible, and that the producer of the SCBA applies the method integer, with taking into account the political choices and assumptions;
   e. An investment of enough time and money in order to fulfill these requurements.
3. Because the result of an SCBA depends on the assumptions with which the model is filled, each SCBA is a unique product of a politically responsible actor. The quality of the political debate on policy proposals may increase when also other stakeholders like the political opposition have the opportunity to have calculated an alternative SCBA on the basis of their own assumptions.

1. Introduction

In the Agenda for the Future regarding the Environment (2006), the Dutch Ministry of Housing, Spatial Planning and the Environment (VROM) writes:

"[In the future] it must be clear that the government, more than is currently the case, has weighed costs and benefits when formulating policy and that the targets of environmental policy are realized in a cost effective way. In order to improve the transparency of decision–making on choices in environmental policy in the future, the cabinet will take care of a clear presentation of all relevant social advantages and disadvantages (cost and benefits). As was mentioned before, also insight will be provided into the costs of 'non–action', as well as into the benefits in the long run and the specific consequences for vulnerable groups in society."

This implies that Social Cost Benefit Analyses (SCBAs) may become a regular part of the preparation of decision–making regarding environmental policy. Therefore, it is important to develop practical guidelines regarding how to construct SCBAs. At the same time it is important to consider when and how to use SCBAs in the policy and decision–making process.

The Dutch government has used SCBAs predominantly for infrastructural projects, and a useful practical guide for this type of issues exists (i.e., the so–called OEI). However, it is to be expected that this guide needs some adjustments in case environmental issues are central in the SCBA. Three issues need more attention: (i) how environmental goods and services can be valued; (ii) how future benefits and current costs or current benefits and future costs can be weighed (that is, the issue of discounting), and how values should be adjusted to correct for risk and uncertainty[2]; (iii) how SCBAs can be integrated in the policy and decision–making process. VROM has asked RMNO to address these three questions.

The first question arises because oftentimes markets for environmental goods and services are highly imperfect, or even do not exist at all. As a result, the true (scarcity) value of these goods cannot be inferred from market prices either because they are unreliable (if the goods and services are traded, but not all (external) benefits and costs are reflected in these prices) or unavailable (if the goods and services are not traded). Then, other valuation techniques need to be developed. The second question arises because of the observation that for many environmental problems, such as climate change, mitigation costs need to be incurred now whereas the benefits arise in the future. Also, the value of the (annual) mitigation costs can be assessed relatively precisely, whereas the value of the benefits are much more uncertain (as the process of climate change as well as its consequences are not yet fully understood). Comparison of different scenarios in cost–benefit analyses requires the ability to calculate net present values, and therefore the discount factor and risk premiums are very important. The third question is also very important, given the complexity of environmental decision–making, and often does not receive sufficient attention in this context.

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[2] Note that valuation and discounting are closely interrelated; it is hardly ever the case in environmental problems that all consequences of a specific project materialize at the same time; very often investments are required for which costs need to be incurred today whereas the benefits materialize over a much longer time frame, and often far into the future. We follow the literature by interpreting valuation as assessing the value of 'goods or bads' in comparison to other goods at the same moment in time, while discounting is used to make comparable the values of 'goods and bads' at different moments in time.

In this advice we focus on addressing these three questions in order to provide a background and a further perspective for the practical implementation of SCBA.[3] Before addressing the issues of valuation and discounting in chapters 3 and 4 respectively, we will first present the general context of SCBAs in chapter 2. If it is easy to attach a monetary value to all costs and benefits, conclusions are straightforward. But this is generally not the case, especially when environmental issues play an important role. This has implications for the standard economic analysis but also for the way in which values can be revealed. Chapter 5 evaluates the role of knowledge in general and the usefulness of SCBAs for environmental policy. Here a guideline is proposed for decision–making using SCBAs. Chapter 6 concludes.

2. General context

2.1 Introduction

Cost–benefit analyses are straightforward if all costs and benefits are known and can be stated in the same (monetary) unit. In that case, standard economics suggests equating marginal costs and marginal benefits, to find the level of environmental quality where the net benefits of increasing this quality by one unit are equal to zero. However, costs and benefits are not all known and are not always measured in the same unit, especially if environmental goods and services are concerned. The question arises as to what we can (and should) do to uncover these values in order to be able to draw policy conclusions. Even if the units of measurement differ, people are able to compare things; even if prices of apples and pears are unknown to an individual, he/she is likely to be able to determine how many pears he/she is maximally willing to give up to receive a certain number of apples, and vice versa. This maximum number implies that if he/she is forced to actually make this trade, he/she is indifferent between having either the relevant number of apples or pears. It is this notion of indifference that economists use to extract a monetary value that can be used in cost–benefit analyses. Indeed, money does not represent more than just the goods and services it can purchase. However, this step of finding the indifference point is not straightforward either. This section is intended to shed some light on these two important problems.

The key concept underlying SCBAs that involve the environment is indeed this notion of indifference, from which monetary values for the positive or negative consequences of environmental changes can be inferred. Consider the case of the government contemplating to implement a project to improve the quality of surface water in the Netherlands. The improvement in the quality itself is likely to constitute a benefit to some individuals. Now there are two concepts to measure value. The first is to ask the question: "How much money (X) can be asked from such a person so that he/she is indifferent between (i) continuation of the status quo (i.e., no improvement in water quality), and (ii) the project being implemented, but taxing the person for X. In this case, X is the so–called –maximum– Willingness to Pay (WTP). The second is to pose the question in a slightly different way: "How much money (Y) should the person receive so that he/she is indifferent between (i) the project being implemented and (ii) the project not being implemented, but receiving Y. Here, Y is the so–called –minimum– Willingness to Accept (WTA). The difference between the two approaches is the

[3] In addition, VROM has commissioned CE Delft to develop a practical guide for SCBA studies.

reference situation: do we search for indifference taking the true status quo as a starting point (in case of WTP), or do we assume that the project has been implemented (in case of WTA)?

Standard economic theory predicts that WTP and WTA should be very close. But empirical research suggests otherwise, as large disparities have been observed between WTA and WTP in many valuation studies. In response to this apparent violation of economic theory the economic profession has started revising its core theories, moving beyond the standard rationality assumption. Explanations for the difference between WTP and WTA were first put forward in the psychology literature, but are now part of textbooks on economic valuation. In fact more and more behavioral models are being developed in economics, influenced by results in psychology, sociology and experimental economics. It is for example recognized that other people's behavior matters, that habits are important, that people are motivated to "doing the right thing", that people are bad at calculations, and that people need to feel involved (Dawnay and Shah, 2005). These insights are important both in the design of policy and in the design of valuation studies. The difference in design between WTP and WTA valuation studies is a clear example of this.

The fundamental starting assumption in most economic analyses remains, however, that humans are able to make informed choices regarding many aspects of their lives, and that the value of all goods and services (at least those that need to be valued, which excludes love or religion) derives from individual preferences. This has proven a very fruitful starting point indeed, even though it means that economists essentially have an anthropocentric view. It does not mean, however, that economists do not respect different preferences or interests, and these may include altruism or any other preference not directly adding to the material welfare of the individual. The great challenge is to determine whether preferences are a stable construct (i.e., not too volatile across time or context) and whether these preferences can be elicited not only by means of studying behavior but also by straightforwardly interviewing people about their preferences. If, for example, people state that a human life is priceless, one would expect that people spend *all* their resources and effort in preventing any threat to human life. This is generally not the case: people apparently make trade–offs and attach a high (but finite) value to human life.

The value of a human life is probably the most contentious item to be valued. Humans place monetary values on their lives quite regularly, and these values provide a useful starting point for analysis. How do people put monetary values on their own lives? The choice of occupation is one, for sure. Depending on their position in society and their level of education, skills and abilities, people are able to select their careers at least to some extent. Chemical engineers, for example, can decide to pursue a relatively safe career as a high school teacher, or they can seek employment in chemical plants where they are exposed to certain (potentially lethal) risks and threats (such as the unintended release of toxic substances, fires, or explosions). These people are aware of this, and when deciding what career to pursue they consider the consequences of dying in a work–related accident (for their spouses and kids). And indeed, for the same job requirements, the high–risk jobs tend to be better paid than low (or zero) risk jobs. The general finding is that to accept a 1% probability of getting killed in some work–related accident, an individual's discounted income stream should be between $60,000–80,000 higher than for the risk–free job option (in OECD countries, resulting in a

value of a statistical human life of between $6 and $8 million; cf. Viscusi, 2000).[4] Therefore, the difference in (the net present value of the flow of) incomes is a measure of how people themselves value their own lives. And if some conditions are met, these values are indeed the minimum WTA for a person to actually accept a high–risk job (or his/her maximum WTP for a risk–free job). Of course, many more examples can be given, including the amount of money spent on preventing fires in their homes, on purchasing smoke detectors, on safer cars or on bicycle helmets (Viscusi and Aldy, 2003).

How do we translate this to a social value? If humans themselves value their own lives at some $6–8 million, why should society place a different value on their lives? Indeed, if the Dutch government would do a risk assessment of say fire safety in bars using the $6 million for any life that is expected to be saved, safety regulations would probably be more stringent than they are today. In our view, the real societal debate is not to put different values on lives than people would do themselves, but how to weigh the different values.

The main compelling argument against economists' using valuation techniques is that it is undemocratic in the sense that 'rich people can afford to pay more than poor people', and hence are able to place higher values on, say, their own lives than poor people can. Clearly this criticism holds for WTP measures, but also for WTA. If one is really hard–pressed for cash, one may be willing to 'sell for less' (state a lower WTA) than richer people. That is, for the same amount of compensation (for example the wage differential in the case of the chemical engineers), a person who expects to inherit a substantial amount of money in a few years' time is less likely to accept the risky job than an individual who does not expect to receive a large inheritance; the richer person's WTA is likely to be larger than that of poorer people. In estimating social values, one should be aware of this. Moreover, in the design phase of policy making it may be important to distinguish these values in order to enable decision makers to choose how to handle these differences.

With these caveats in mind, the key difference between SCBA techniques developed by economists and all alternative valuation techniques available (including multi–criteria analysis, MCA) is that SCBA tries to detect *indifference points*: how much consumption possibilities (as captured by money) are individuals willing to give up in exchange for a specific project (environmental or otherwise) being implemented. In that sense it takes one step further than, for example, MCA. When evaluating whether cafes and bars should have more stringent fire prevention rules, both try to find out what the costs are of the extra measures as well as how many lives will be saved in expectation. MCA stops at the point of saying that these measures will save, say, 10 lives (in expectation) and that it is up to the decision maker whether she thinks that saving 10 lives is a sufficiently large number to warrant the extra costs imposed on the owners of bars and cafes. But SCBA takes the extra step of arguing that if individuals themselves are not willing to give up more than (say) $60,000 of consumption possibilities to reduce the probability of dying in a work–related accident by 1%, the value of

[4] Note that the term used is 'a statistical human life'. Nobody argues that one is entitled to kill another person as long as he/she gives his/her victim $6million. But accidents happen, and the probabilities of getting killed in a work–related accident are low. People are willing to accept these low (but non–zero) probabilities as long as sufficient compensation is forthcoming.

an *expected* human life is \$6 mln, and hence the safety measures should only be implemented if their costs are smaller than \$60 mln.[5]

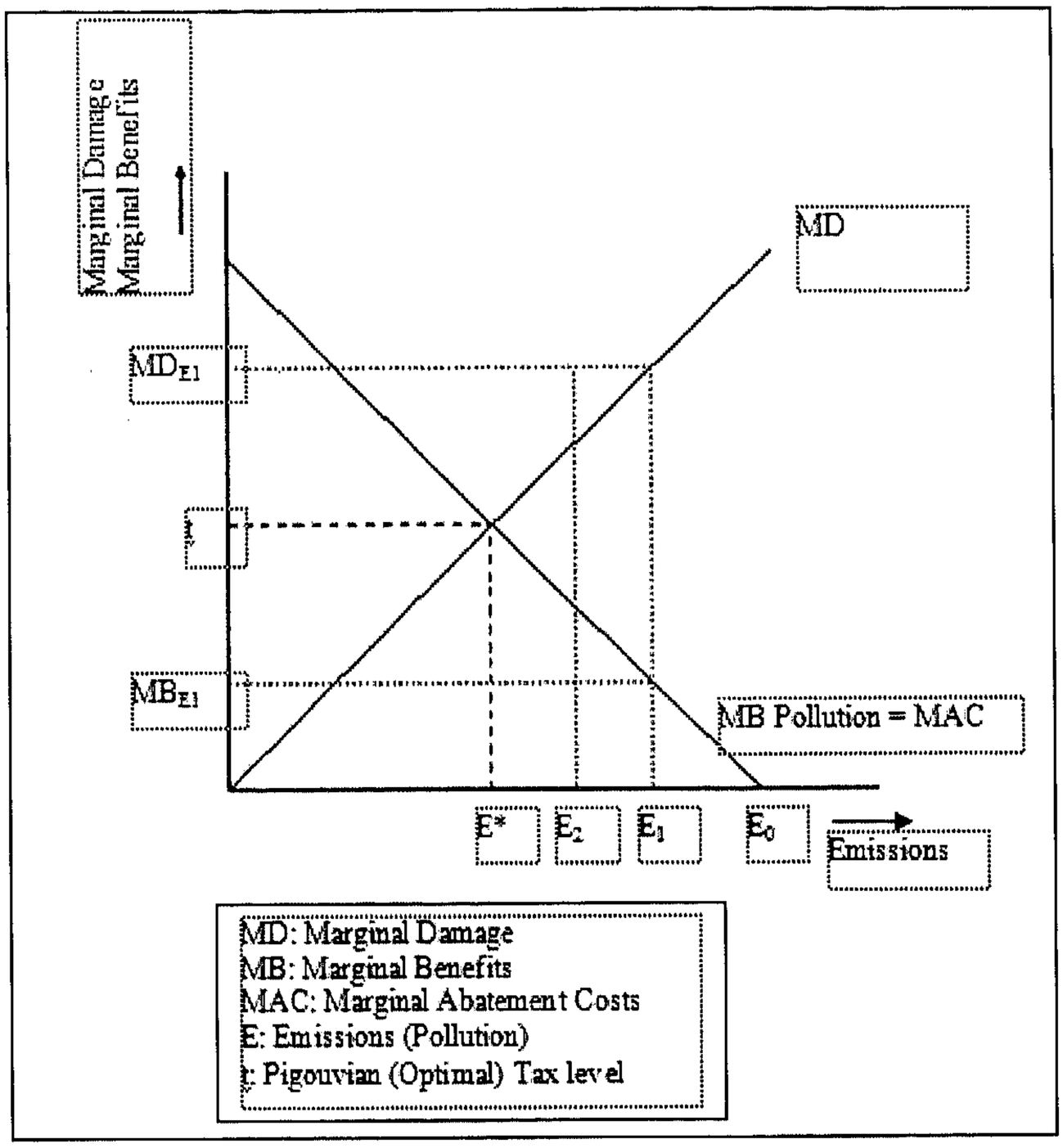
2.2 Optimal policy versus 'steps in the right direction'

Valuation is needed to determine the optimal amount of environmental protection provided. Take the example of putting quotas on the emissions of greenhouse gases. The optimum is where the costs of restricting emissions by one additional ton of, say, CO_2, are equal to the benefits of doing that. The costs include the reduced profits for firms that are no longer allowed to emit that ton of CO_2, the costs of increasing energy efficiency, etc. These costs can, in principle, be estimated fairly easily as they pertain to financial flows (but see below). The benefits are however much more difficult to assess. The benefits of not having to raise the dykes as much as without the regulation are not too hard to estimate. But what about the benefits of various types of birds not going extinct (locally in the Netherlands) because of these regulations? This is why valuation studies are needed to guide policy making.

The optimal amount of pollution or environmental degradation is hardly ever equal to zero. In most instances, the first unit of pollution produced does not cause much damage, while the benefits of being allowed to emit that unit (in terms of the goods that can be produced) are very high. As the amount of pollution increases, benefits of being allowed to emit additional units (the so–called marginal benefits) of polluting substances fall, whereas the damage associated with that extra pollution (the marginal damage) tends to increase. This gives rise to the standard figure environmental economists use to determine the optimal amount of pollution; see figure 2.1. In this figure, the MAC is the marginal abatement cost function and MD is the marginal environmental damage function. Whereas in the absence of environmental policy the amount of emissions would equal E_0, the challenge for the policy maker is to reduce emissions to E^*.

[5] To see that this line of reasoning is correct, suppose there are 1000 people in a group, and that the probability of a fatal accident is 1% for each. That means that in expectation 10 people will die unless actions are undertaken. The group as a whole is willing to pay \$60 mln.

Figure 2.1: The optimal level of pollution (E) and the net benefits of movements toward the optimum



Of course, life is not as simple as this graph suggests; there are many uncertainties regarding both the marginal abatement cost curve (also referred to as the marginal benefits of pollution) and the marginal environmental damage curve, especially if costs and benefits extend into the future. But suppose the two functions are known with certainty. That means that environmental economists have done a good job in estimating both functions, using various valuation techniques to trace the two curves. Then it is up to the policy maker to implement the optimum, either by setting an optimal quota (E^* in the graph)[6] or by introducing a so–called Pigouvian tax (t in the graph), which is equal to the marginal damage *in the optimum*. Why quota work is obvious; why taxes work may need some extra discussion. When confronted with a tax on every unit of the polluting substance emitted, firms compare the costs of abating that unit to the tax they need to pay. Then they decide to reduce emissions by E_0–E^* units, and pay a tax t per unit for the remaining E^* units of emissions. Up to the amount E_0–E^*, the per–unit costs of emission reduction are smaller than the tax the firm needs to pay for each unit of emissions, and hence the firm saves money by cleaning up these units itself. Any

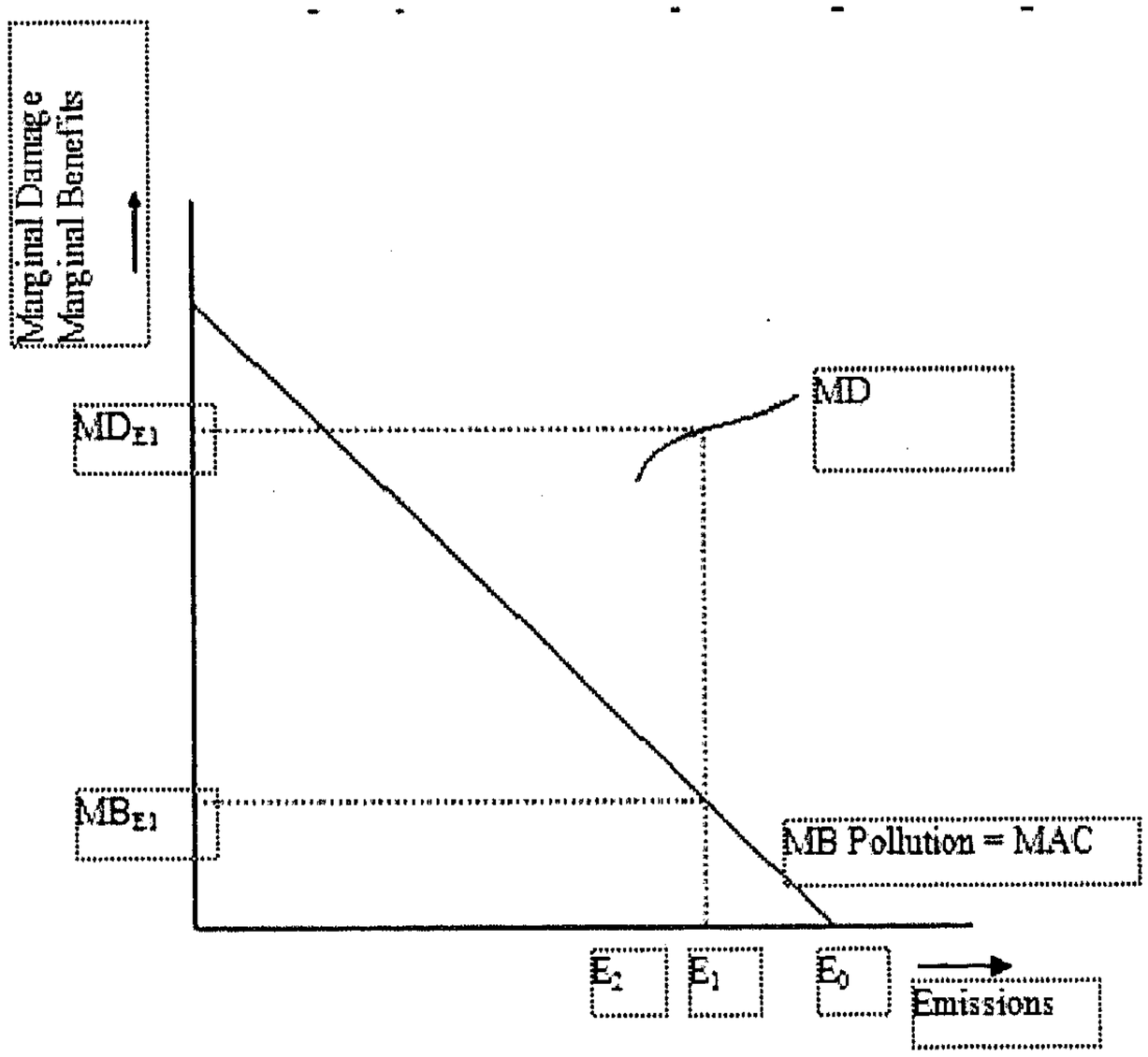
[6] The aggregate quota can take the form of non–tradable pollution permits, or tradable permits ('cap–and–trade').

further reduction below E^*, however, requires per–unit costs that are (eventually much) higher than the tax.

The marginal abatement cost curve can also be interpreted as a demand curve for pollution: the higher the price one needs to pay to emit, the less one decides to pollute. Similarly, the marginal environmental damage curve can be interpreted as a supply curve for pollution: the higher the compensation, the more pollution people are willing to accept. In the optimum, the price is equal to tax t. We call this price the Pigouvian price, but sometimes this value is referred to as the "shadow price". The shadow price is then defined as the price that results if a market for pollution would exist.

Sometimes life is indeed as simple as suggested above but more often it is the case that the exact shape and location of the two curves are not known. For example, it may well be the case that there is good information on what it costs to reduce pollution but that less is known about what this saves in terms of environmental damage. This situation is depicted in figure 2.2. In the terminology of figure 2.2, this means that the marginal abatement cost curve can be drawn but that less is known about the marginal damage curve.

Figure 2.2: Environmental policy with an incomplete marginal damage curve.



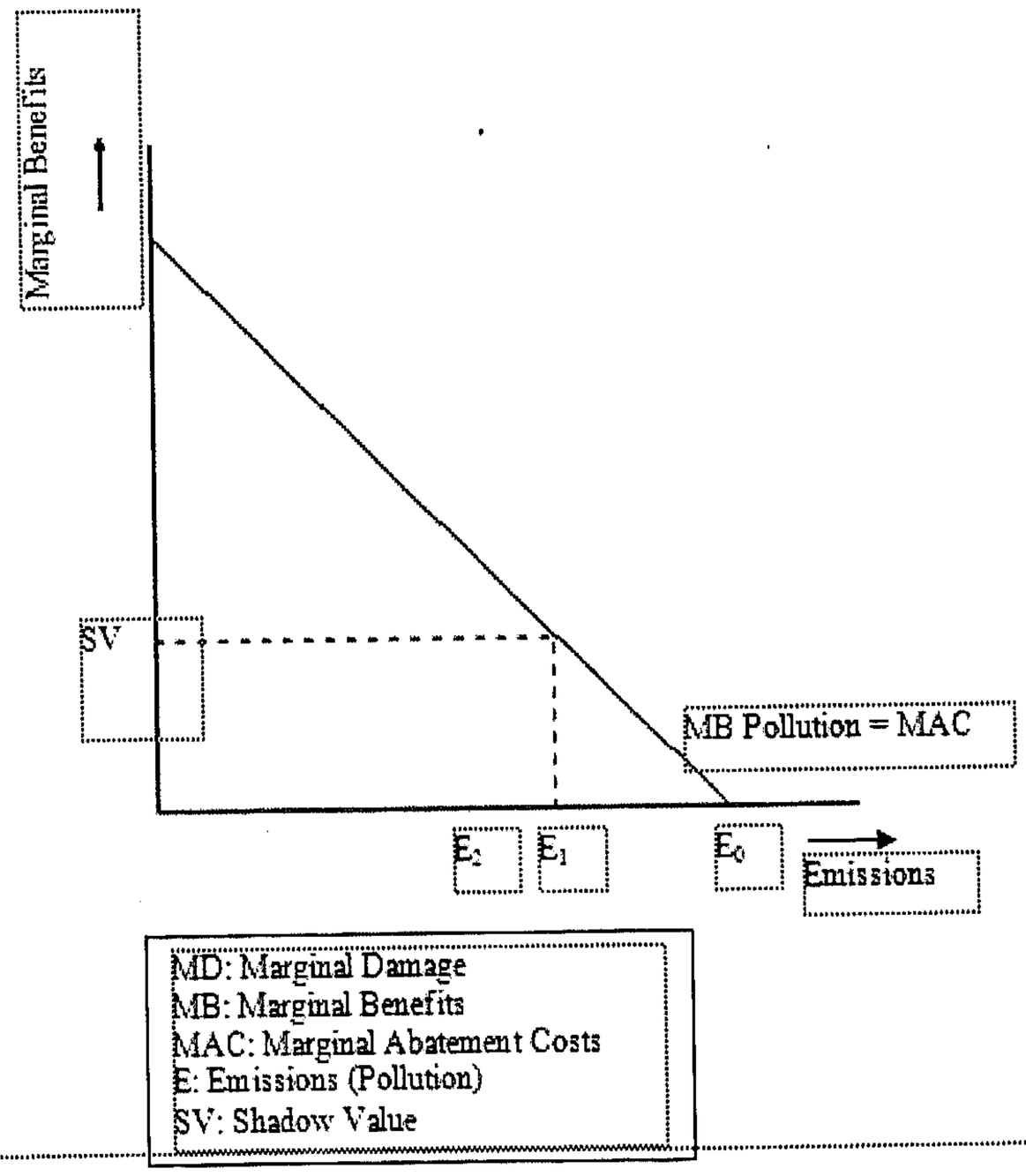
MD: Marginal Damage
MB: Marginal Benefits
MAC: Marginal Abatement Costs
E: Emissions (Pollution)

In that case the optimal quota E^* and the optimal tax t (or the shadow price in the optimum) cannot be determined. It is to be expected that the current level of pollution, say E_1, is higher than the optimal level E^* but lower than the level E_0, because some environmental policy is already in place. The question is how to evaluate a proposal to tighten the quota to

the level E_2 (or to increase the tax rate t to the corresponding level). In figure 2.1 the answer is clear: the net benefits of tightening the quota from E_1 to E_2 are equal to the area between the marginal damage and marginal abatement cost functions, in between the vertical lines E_1 and E_2. Even if the full marginal damage curve is not known, as in figure 2.2, local information at this point is sufficient to be able to make the evaluation. If damage valuation at the current level of pollution is feasible, the policy direction is clear. Namely, if, at the current level of pollution, the marginal abatement cost is lower than the marginal damage (as in figure 2.2), pollution quota should be tightened or the tax rate should be increased.

In case it is not possible (or too expensive) to gather any information on the marginal damage, the only thing that is left is to calculate the abatement costs and to judge whether these costs are worth lowering pollution from E_1 to E_2. The costs of lowering the pollution quota from E_1 with one unit is the shadow value of pollution, which can be approximated by the marginal abatement cost in this case, see figure 2.3. A decision to lower pollution is implicitly based on the assumption that this shadow value is lower than marginal damage in E_1. We are back at the original decision rule. It is clear that policy makers are completely in the dark if we do not have some indication of (the location of) the marginal damage curve. This is why valuation of environmental goods and services is such an important issue.

Figure 2.3: Environmental policy with an unknown marginal damage curve.



2.3 The applicability of SCBA

Some people argue that the *marginal* analysis above is useful only for projects involving small changes. Given the uncertainties regarding the slopes and locations of the two functions, the legitimate question arises whether SCBAs can be applied to projects that involve large changes, that have a (very) long time horizon, or that are very complex with high risk profiles. Indeed, in the extreme case, economists may be able to only infer the marginal damage and marginal abatement costs at the current level of environmental pollution (i.e., level E_1 in the above graph), but have no means to assess the impact of changing the environment more than by just a very small amount.

We are, however, of the opinion that SCBA is a useful tool for decision making in virtually all cases, under certain conditions (see section 5.5). What is essential is how one views the role of SCBAs in decision making. Indeed, in our opinion SCBA can never provide an absolute decision rule (nor is it intended to); it is nowhere written in stone that if the benefits exceed (fall short of) the costs, the project should (not) be implemented. The sole purpose of SCBA is to take stock of all the possible benefits and costs associated with a specific problem, and, if possible, to place a monetary value on them to make them comparable (by exploiting the idea of indifference to obtain maximum WTPs or minimum WTAs). Having gathered information regarding the pros and cons of the project in a SCBA, it is up to the policy maker to decide whether the project should be implemented, or not. If the monetarized costs of implementing a project exceed the benefits by just one euro, it does not follow that the project should not be implemented. Rather, the decision maker now knows that the monetarized benefits and costs are roughly equal. Whether or not the project should be implemented then depends on what types of benefits and costs have not been monetarized yet, how uncertain the numbers are that have been obtained on the benefit or cost side, on the distributional effects, etc.

Indeed, one may wonder whether the value added of SCBAs is largest for simple, static problems, or for more complex, long–term problems. Obviously, uncertainty increases with complexity and with longer time horizons, but the need for information is also greater. And if one views SCBAs as a means of gathering relevant information in a systematic way, they are still very useful.

Related to this, SCBA is not the only available tool; Multi–Criteria Analysis (MCA) has also been developed to guide policy–making. It is interesting to note that people often argue that we should either use the one or the other. In fact, SCBAs can very well take up an important aspect of MCAs. If certain values are hard to quantify, this can be mentioned in an SCBA. Or, if certain values are based on different positions in society, such as the example of the value of a human life discussed above, this can be made explicit in an SBCA. In this way the policy maker can weigh all these issues when deciding to implement the project, or not, so that MCA could always be done at a later stage in the analysis.

Chapter 5 addresses more in detail how SCBAs may be used in decision–making processes.

3. Valuation

3.1 Introduction

In this section we will address how the abatements costs and environmental damage can be estimated, so that they can be used in either discrete or marginal cost–benefit analyses. The focus of this report is to estimate environmental damages, but calculating abatement costs is not trivial either. To illustrate that, section 3.2 explains how abatement cost functions can be constructed. Then we move on to presenting the theory on the valuation of environmental goods and services. In section 3.3 we briefly explain what types of values exist, and briefly present two classes of valuation techniques that are available to actually estimate these values. We make the distinction between those techniques that are based on observed behavior (revealed preference approaches, also known as indirect indirect valuation techniques) and those that are based on a survey approach (stated preference approaches, also known as direct methods). The revealed preferences techniques make intuitive sense and are well–accepted in the literature, and therefore we discuss them only briefly in section 3.4. From the set of stated preferences technique the Contingent Valuation Method has been subject to much criticism, but has features that make it the preferred technique at least in theory. We discuss how the reliability of the results of CVM studies can be increased in section 3.5. In section 3.6 we conclude.

3.2 Measuring the marginal abatement cost functions

Obviously, marginal *damage* functions are difficult to assess, but measuring the marginal abatement *cost* functions is not straightforward either. In the first place, any government intervention affects prices in the economy, and hence ex–ante prices may be a poor basis for calculating actual (marginal) abatement costs. A very stringent carbon tax, for example, will substantially increase the demand for (abatement) capital, thus driving up the price of capital, and hence long–term abatement will turn out to be more expensive than if a fixed price of capital is assumed. Also, environmental policies may worsen existing distortions in the economy, thus effectively increasing the abatement costs.[7] These "general equilibrium effects" are important, and need to be taken into account.

But even when abstracting from these complications, estimating marginal abatement cost functions remains a tricky exercise. And, unfortunately, in retrospect the estimates can be far from correct (see for example Oosterhuis 2006). Environmental damage can be mitigated

[7] For example, the introduction of a stringent cap on the amount of greenhouse gases increases the production costs of firms, and hence also the sales price of carbon-intensive goods (even if the emission permits are grandfathered). This effectively decreases purchasing power of workers' salaries, inducing them (at the margin) to work fewer hours. This effect is more severe the larger are the existing marginal income taxes (as they already induce people to work less than absent any distortionary taxation). Note that this is just an example; it may well be the case that people will work *harder* if (the purchasing power of) their salary decreases –because they still need to pay the mortgage *and* drive their cars. But the message is clear; the net change in welfare resulting from environmental policies may be dependent on the presence or absence of other imperfections and distortions in the economy.

in various ways, and the least–cost combination of these various methods is the marginal abatement cost function. Consider the case of noise pollution resulting from Schiphol airport. Noise pollution can be reduced (i) by reducing the number of flights, (ii) by banning the noisiest airplanes from using Schiphol, or (iii) by improving residential homes' insulation (double–glazing, extra layers of insulation in walls, different tiles on the roof, etc).

Suppose that the total costs of reducing noise pollution by 10dB by reducing the number of flights (foregone revenue) are 1 million euros, by 20 dB 3 million, and by 30dB 6 million euros. That means that the marginal costs of reducing the number of flights is 1 million for the first unit of 10dB, 2 million for the second unit of 10dB, and 3 million for the third. Suppose that the cost functions for banning noisy planes or installing double–glazing are exactly the same: 1 million euros for 10dB, 3 million for 20 dB, and 6 million for a 30dB reduction. These numbers are summarized in table 3.1.

Suppose that the objective is to reduce noise by 30dB. If one only considers any single of the three options, the total costs incurred equal 6 million euros. If one considers all three options, total costs equal 3 million euros (abate 10dB by means of fewer planes, abate 10dB by means of banning noisy planes, and 10dB by means of improving home insulation). The marginal abatement cost curve is the least cost combination of all available options.

Table 3.1: Total and marginal abatement costs for different levels of abatement.

Reduction Costs	– 10dB	– 20dB	– 30dB	– 40dB	– 50dB	– 60dB	– 70dB	– 80dB	– 90dB
Total abatement costs	1	2	3	5	7	9	12	15	18
Marginal abatement costs	1	1	1	2	2	2	3	3	3

Graphically, the marginal abatement cost function is just the (horizontal) summation of the marginal cost function of all the available mitigation options. The challenge is to find all mitigation options, analyze whether they are in fact complements or substitutes (i.e., mutually exclusive) in mitigation and to infer their costs as well as their effectiveness.

3.3 Measuring the marginal damage functions

Key to estimating environmental damage is the identification of the various types of values that may be associated with a certain environmental good or service. Two broad categories are use and non–use values. Use values are those values that are associated with actually 'using' the environmental good or service, i.e. the pleasure people derive from hiking in a national park, the annual profits obtained from sustainably extracting timber from that national park, etc. When people actively use an environmental good, it is not too difficult to establish the appropriate value for the good under consideration. The profits obtained from sustainable logging are easy to calculate, and the fact that people spend money to actually visit the national park provides a lower bound estimate of the value of the resource under consideration (see the discussion of the Travel Cost Method in section 3.4.2 below). And if

these various types of uses are not mutually exclusive (as is the case with sustainable logging and recreation), the total use value of the environmental good is the sum of these values.

Things are more difficult however, because of the existence of so–called non–use values. People attach value to environmental goods or services even though they do not use them at the moment, or even do not intend to ever use them. An example pertaining to future use is that we may not be producing a medicinal drug from a certain plant species because we do not know of its beneficial characteristics yet, but there is a certain probability that we will discover this useful property in due time and thus the conservation of this particular plant species does have a value. Another example is that people attach value to the fact that there are still tigers living in the rainforests of Sumatra: even though it is unlikely that any of us will ever see a Sumatran tiger in the wild, we attach value to the knowledge that this (magnificent but generally very shy) animal still survives in the wild. We also care about whales for the same reason, although we can go on boating trips to view them in the wild. As soon as we have seen one or some, this value does not disappear; we continue to like the idea that there are still whales on this planet, and we also attach value to our children or our neighbors having the chance to view them in the wild.

The above–mentioned non–use values are labeled quasi–option value (the example of the plant species), existence value (the tiger example) and bequest value (the example of the whales still being around for the future generations to enjoy). The problem with these non–use values is obviously that we do not observe any expression of people attaching value to these goods, unlike the case of the use values. Of course people donate to environmental NGOs but it is difficult to infer the existence value of the Sumatran tiger or the Minke whale from a person's donations to Greenpeace.

Given these various types of values, several techniques are available to actually estimate them. The main distinction is between so–called revealed preference techniques (also known as indirect valuation methods) and stated preference valuation techniques (also known as direct valuation methods). Revealed preference methods make use of actual choices made by people in actual markets. Although impacts of policies and projects are often not directly traded, sometimes they are traded implicitly. In that case observed prices/behavior can be used to estimate the marginal damage function. However, because actual choices in actual markets are used, revealed preference methods cannot find a value for non–use values. This value may be an important input in decision making if it is substantial, as may well be the case for some types of natural amenities. Furthermore, revealed preference methods often need strong behavioral assumptions, which are not easily testable. The hedonic pricing method (HPM), the travel cost method (TCM) and the averting behavior method (ABM) are the most important examples of revealed preference methods and they are discussed briefly in section 3.4.

Stated preference methods, on the other hand, use choices people make in hypothetical situations. Individuals are asked by means of surveys how they would hypothetically value changes in the availability of some non–market good. An obvious disadvantage would be "ask a hypothetical question and you will get a hypothetical answer". People may have difficulty in determining how they would actually act in the described hypothetical situation, they may not really care about the answer they give since it is hypothetical or they may have strategic reasons for misrepresenting their valuation. Care should therefore be taken to eliminate these misleading answers. But stated preference methods have advantages too. They are the only techniques available to estimate non–use values (such as existence or bequest values): they are able to find valuations for goods that are not even implicitly traded on markets. The contemporaneously most widely used and discussed stated preference method is the contingent valuation method (CVM). This method will be described in section 3.5.

3.4 Revealed preference methods

There are three main revealed preference methods, the so–called Hedonic Pricing Method (HPM), the Travel Cost Method (TCM) and the Averting Behavior Method (ABM). We will discuss all three briefly in the following subsections.

3.4.1 The Hedonic Pricing Method (HPM)

HPM uses the fact that market goods consist of a bundle of characteristics, some of which may comprise non–market goods, such as natural amenities. This bundle determines the market price for the good (Taylor 2003). Take the example of residential houses. The sales price of a home depends on its size (the number of cubic meters), the size of the garden (number of square meters), the state of maintenance (good, or poor), the proximity to schools and/or supermarkets, and also the quality of the local environment. All other characteristics being equal, a house close to Schiphol airport will sell for less than a house that is located in a quieter area. Of course, no pair of houses is identical except for environmental quality, but standard regression techniques can be used to estimate the impact of environmental quality on the sales price of houses. By regressing the market price on, if possible, all characteristics of the marketed good (the house), the marginal WTP for a change in any one of the characteristics (including local environmental quality) can be estimated. This is the implicit price. Using this price, a demand curve for the characteristic of interest can be derived, which in turn is used for estimating its economic value.

Indeed, HPM is often used in the valuation of natural sites using house prices. For example, Fennema (1995) found that the view on a green park leads to a 6–8% increase in the house price. From this the value of the park can be estimated. Sijtsma et al. (1996) found that people are willing to pay about 10% more for houses with twice as much green space than regular areas. Again, this number can be used to estimate the value of the green space in residential areas with the caveat that it provides, by definition, a lower–bound estimate of the actual value, as non–use values are ignored.

In its simplest form[8], HPM does not require as many data as other (revealed preference) valuation techniques (Taylor 2003). For example, to estimate the value of noise pollution associated with Schiphol Airport, it suffices to obtain the sales records of real estate agents in the region plus a measure of noise pollution at each possible location. The sales records contain information on sales prices, number of rooms, quality of maintenance, proximity to schools and supermarkets, etc. Combined with the noise data, the researcher can regress the sales price on this entire set of characteristics determining the property's sales price, and a measure of noise damage is obtained.

All this does not mean that the approach is straightforward. There may be problems with multi–collinearity in the regression (for example, the emission of noise and other polluting substances are positively correlated in case of Schiphol Airport), or there may be omitted variables (e.g., differences in crime rates affecting the value of property). Representativeness

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[8] In technical terms: that is, when only the first stage analysis is called for. If the problem requires the second stage to be implemented too, then data requirements are considerable.

of the sample for the population is also a matter of concern, since people who do not buy a good with a certain type of non–market characteristic may still value this characteristic. HPM can in most cases not be used to estimate the total value of some non–market good, since there are often welfare–generating characteristics of this good which are not valued in the prices of marketed goods (such as non–use values).

3.4.2 The Travel Cost Method (TCM)

TCM is mainly used for the valuation of recreational areas. The main idea is that the amount of money people spend on, say, visiting a national park, provides a lower bound estimate of their valuation of this park (Perman et al. 2003, Ch. 12). Costs consist of time and transportation costs. The total costs incurred indicate the value of recreation and thereby indirectly the value of the natural amenity at that site to an individual. Information needed to apply TCM is usually collected through a survey at the recreational site of interest, although this not necessarily the case. What is needed is information on the number of trips to the site an individual makes and the costs of a trip. A demand curve for the natural amenity can be derived from these data. In the Netherlands, to give an example, Brouwer et al. (2003) conducted a study to estimate the socio–economic value of natural water levels in Frisian lakes using TCM. More specifically, the TCM was applied to estimate the current recreational use value of the area. Brouwer et al. interviewed tourists. Travel cost estimations are based on the distance between the home address and the holiday address (to and from). The estimated consumer surplus per visit is 50.30 euros. On the basis of this, the average annual benefit stream generated by the Frisian lake area is calculated to be 185 million euros. Again, this is a lower–bound estimate of the actual value, as non–use values are ignored.

There are problems with TCM as well. The recreational site need not be the only goal of the trip. In case of a *multi–purpose* trip it is difficult to assign the correct share of the costs to the visit of the recreational area. For example, Europeans may spend thousands of euros travelling to the US to see the Grand Canyon, but this is not likely to be the only reason for traveling to the US; other nature parks are located in the same area (Bryce Canyon, Death Valley, Yosemite), and the tourists are also likely to visit Las Vegas and San Francisco. People may also not be fully aware *ex ante* of the enjoyment they will experience from a visit. Furthermore, people that never visit a recreational site do not necessarily value the site at zero. However, they are excluded from the sample, because they cannot be surveyed at the site of interest. TCM only measures the recreational, or use–value of nature, so it is an insufficient method for measuring the total value of nature.

3.4.3 The Averting Behavior Method (ABM)

The third revealed preference technique deserves special attention because it can be used to either assess benefits of damage reduction, or as a mitigation technique (and hence part of the marginal abatement cost function). This is the averting behavior method. It consists of inferring how much people value an improvement in environmental quality by measuring how much money they actually spend to insulate themselves from environmental bads. For example, suppose people living in the vicinity of Schiphol are observed to spend 10,000 euros on double–glazing, thus reducing the decibels in their home from 80 to 40. This gives a lower bound of the value they attach to reduce the environmental bad.

But, joint production should be taken into account. In the case described here one could think of energy–saving by installing double–glazing. If installing double– glazing reduces a

person's energy bill by 5,000 euros, we can infer that the minimum amount he/she is willing to pay for a decrease in noise pollution from 80 to 40 dB is 5,000 euros, i.e. it is the *net* cost of the expenditure which is the correct measure of the valuation of the reduction in the environmental bad. However, a problem arises here in the sense that damage is only partly prevented. For example, in the garden one is still exposed to 80dB of airplane noise. This means that the 5,000 euros mentioned before are indeed a partial or lower bound estimate of the valuation of the environmental bad. Another problem is that only people who expose certain types of averting behavior are taken into account. People who prevent exposure to the airplane noise in some other way than by installing double–glazing are possibly not accounted for, for example.

3.5 Stated preference method: CVM

The revealed preference methods are well–suited to measure the various use values of environmental goods and services. However, there are non–use values too, such as the bequest and existence values. Basically, from the actual behavior of individuals it is not possible to infer whether they hold such preferences (and if so, how strong). That means that the only way to estimate the existence and bequest values is by means of using survey instruments.

In the valuation literature, two survey–based valuation techniques are used most often: the Contingent Valuation Method, and the Discrete Choice analysis. In the Contingent Valuation Method (CVM) respondents are confronted with a description of the environmental project (including the various environmental, social and economic consequences it entails) and then are asked directly how they value this project. The questions asked are simply either the respondent's WTP or WTA, and the way in which the question is asked is either open–ended ('what is your WTP?'), or closed ('are you willing to pay 10 euro's, yes or no?'). This technique has been heavily criticized (see for example Diamond and Hausman 1994), and the Discrete Choice analysis has been developed to at least partly address the criticisms raised. In the Discrete Choice (DC) framework, respondents are confronted with (usually multiple) binary choice situations. The respondents are asked to choose between two alternatives, which differ with respect to the various attributes that are of importance (such as the level of the various aspects of environmental quality). One of the attributes has a monetary value, and by analyzing what alternatives are chosen by the respondents the researcher is able to infer the monetary valuation of the various (environmental and non–environmental) attributes.

The DC approach has been developed to improve upon the CVM in various ways. One such improvement is that by directly comparing alternatives, the incentives for strategic misrepresentation are less obvious than with the CVM approach. A second is that because of the fact that multiple comparisons can be offered to the respondents, the method is less costly (or more efficient from a statistical point of view). Third, if there are still incentives for strategic misrepresentation, the fact that more than one choice situation are offered can be used to detect such inconsistencies in the alternatives chosen.

Given that CVM is still the most famous and also the most contentious of the two approaches, we will focus our attention on the usefulness of this technique.

We will first briefly describe how a CVM study looks like in section 3.5.1. Then we will discuss a specific problem affecting the reliability of CVM, namely so–called hypothetical bias, in section 3.5.2. Section 3.5.3 briefly presents some general guidelines for conducting a CVM to improve its reliability further.

3.5.1 The Contingent Valuation Method

A contingent valuation study is a survey–based approach in which people's WTP or WTA for a change in environmental quality is derived directly (for an overview of the technique, see Boyle 2003). The first part of a survey usually consists of some attitudinal and behavioral questions about the good to be valued. Next, people are presented a hypothetical situation in which a change in the quality of the environment is provided. Information is given on the reliability and quality of this provision, the timing and the method of payment, etc. Finally, demographic and socio–economic questions are posed to yield background information and to check for the representativeness of the sample. If all this information is gathered from a large enough sample the welfare effects of a change in environmental quality can be estimated. These welfare effects include non–use values, which cannot be estimated by revealed preference methods.

The first and third part of the survey are relatively straightforward. The second part of the survey is more troublesome, but very important in deriving useful results. Here the good to be valued is presented, the hypothetical scenario is described and the valuation question is asked. All have their own problems. With respect to the good to be valued, there may be uncertainty about the effect of changes in behavior on the environment, there may be uncertainty about the effect of changes in the environment on human wellbeing and it may be difficult to present the possibly multi–dimensional effects in a clear manner to the respondent. All these problems hinder valuation by the respondent. The presented hypothetical scenario should be accurate, though not too long. It contains a description of the policy change, of the (social) context in which the change takes place and of the method of payment. The scenario should be plausible. The method of payment is also important. If taxes (or rebates) are used, for example, people may simply express a low WTP/high WTA because of some general aversion to taxes. But if voluntary contributions are used, people may overstate their WTP because they may anticipate not to contribute in reality (as they may decide to free ride in practice). The way in which the WTP/WTA question is asked also is relevant. For example, open–ended questions, payment cards or referendum methods may be used. Possible problems, depending on the type of question used, are that people may have no idea about the valuation at hand (therefore, CVM seems to be most accurate for publicly–managed goods with private characteristics, such as natural sites), anchoring (starting point bias) or yea–saying. Nowadays the referendum approach seems most popular. In this approach people are simply asked if they would want to have policy A executed for a price of x. This resembles daily purchase decisions.

Other problems with the CVM include the hypothetical bias ("ask a hypothetical question and you will get a hypothetical answer"), scope problems (the valuation is insensitive to the amount of change in environmental quality) and information bias (the way information is presented may influence the respondent's decision). Careful designing of the survey may help reduce these problems. The acceptance of the CVM among academics and policy makers has increased substantially over time.

The most famous and probably most important contingent valuation (CV) study so far is the one on the Exxon Valdez, as described in (Carson et al. 2003). In March 1989 the Exxon Valdez, an oil tanker, ran into submerged rocks, releasing 11 million gallons of crude oil into the Prince William Sound in Alaska. The court's ruling that non–use values should be taken into account in damage assessment instigated the start of a CV study. In the study in–person interviews were held with people from all over the US. The questionnaire was carefully designed with, among other things, a careful description of the Prince William Sound and a description of the effects of the oil spill on the wildlife. People were told that a special one–

time federal tax was the payment vehicle. The valuation question was asked in a discrete–choice referendum format. This means that respondents were asked if they would vote for a certain policy if the one–time tax was $x, yes or no. Every person was asked one follow–up valuation question, depending on the answer given. The lower bound estimate of the aggregate lost non–use values was $2.8 billion dollars. This may have played a role in the ultimate out–of–court settlement between the State of Alaska, The US Government and Exxon for $1 billion.

3.5.2 CVM and hypothetical bias

The great advantage of the CVM is able to provide estimates of the non–use values. Revealed preference methods are not able to do this. Therefore, the CVM certainly has added value. However, as mentioned before, the CVM is prone to 'hypothetical bias': people are often found to respond significantly different to real and hypothetical valuation questions (though not always, see for example Dickie, Fisher and Gerking (1987), who cannot reject the null hypothesis of statistically identical demand relations for strawberries found using either market demand or hypothetical demand data). More specifically, people generally tend to show a higher WTP when answering hypothetical valuation questions compared to answering real valuation questions. For example, Cummings and Taylor (1999) find that the probability of a yes–vote in a referendum, when people are asked whether they agree on a €10 contribution for different public goods, may be as much as 25 percentage points higher in case the referendum is hypothetical compared to when it is real. Bulte et al. (2005) investigate the valuation of seals in the Waddenzee using both a purely hypothetical and a less hypothetical scenario, in the sense that in the latter case it is indicated that the results will actually be considered by policy makers. They conclude that people state a significantly higher WTP for saving these seals in the purely hypothetical case. As a final example, List and Shogren (1998) find that people's hypothetical bids for baseball cards were between 2.2 and 3.5 times higher than the actual bids. In general, results from meta–analyses indicate that mean hypothetical values are about 2.5 to 3 times greater than actual values, but, it should be noted, with a median ratio closer to 1.5 (Murphy and Stevens, 2004).

The extent of hypothetical bias may be related to the amount of money at stake, the bias being greater as the money amount increases. This may be caused by the fact that respondents do not take hypothetical payments seriously. As a result, decisions of respondents paying real money will be responsive to the amount to be paid, while those in an identical, but hypothetical situation, will be less responsive (or even not responsive at all). This implies an increasing hypothetical bias as the payment amount increases (Ash, Murphy and Stevens, 2004). The risk preferences of individuals may also play a role. Evidence shows that subjects often display a sharp increase in risk aversion for actual, but not for hypothetical payments. This implies that people are much more risk averse for high real payment levels than for similar hypothetical payment amounts (Holt and Laury, 2002).

There is also evidence that the hypothetical bias is larger for public goods than for private goods (List and Gallet, 2001). A possible explanation is that if the respondent positively values a good, and if his response to the valuation question increases the likelihood of provision of the good at no or little costs to him, it makes sense to report an inflated value. This means public goods valuations would be more inflated than private goods valuations, since provision of the latter imply direct extra costs to the individual. In other words, private goods do not suffer from free riding.

So, there is evidence that hypothetical bias is present, that this bias increases with the amount of money at stake and that it is higher for public goods than for private goods. But

what are the underlying causes of this bias? Murphy and Stevens (2004) provide an overview of some possible causes. First of all, the inconsequential nature of a hypothetical scenario may play a role, but this cannot explain the direction of the bias. It may provide an explanation for why people misstate their value, but not why they would overstate it. A second explanation would be the one described earlier, namely that if an individual values a good positively, and if her response to the valuation question increases the likelihood of provision of the good at no or little costs to her, it makes sense to report an inflated value. However, this only explains the existence of a hypothetical bias in public good valuation, whereas the hypothetical bias is also found for private goods. Finally, the third possible explaining factor that is described is respondent uncertainty. When individuals are asked whether they are willing to pay a rather extreme amount (either extreme small or large), they typically have a good idea about what decision they want to make. However, uncertainty sets in if the amount is only intermediate. This uncertainty may influence the answers to the real and hypothetical valuation questions unevenly. Again, the consequences for hypothetical bias are not straightforward. Different models yield different predictions, some even predicting that actual values should exceed hypothetical values.

The above at least makes clear that much more research is needed to really understand the causes of hypothetical bias. However, this lack of understanding does not imply that no efforts have been made at addressing hypothetical bias. One rather straightforward approach is to use a calibration technique. In this case a statistical function is estimated to link hypothetical and actual valuations. An example of a successful application of this technique is Hofler and List (2004), who used it to predict actual bids for sports memorabilia from hypothetical bids. The main problem with this method is that the actual calibration functions may be context, commodity or individual specific. Generalization of a calibration function is therefore difficult if not impossible.

Another method for addressing hypothetical bias is the use of so–called cheap talk. This is an *ex ante* method, in which the interviewer tries to elicit true values from a respondent by reading a script that makes the respondent aware of the hypothetical bias problem. No information on the causes of hypothetical bias is needed. The idea simply is that hypothetical bias will be eliminated by making people aware of it. Cummings and Taylor (1999) and Bulte et al. (2005) are among the studies that have used cheap talk to eliminate hypothetical bias successfully. The first study finds that for the three out of four public goods where hypothetical bias was present, the cheap talk design elicited responses to hypothetical valuation questions that were indistinguishable from responses to valuation questions that involved actual payments. The latter study concludes that the values found for the WTP for saving seals in the Waddenzee, using a cheap talk script or a scenario that poses that the results will actually be used, do not differ significantly, whereas the value found in the purely hypothetical scenario significantly exceeds these two values. The precise script used is of great importance and can influence results. This should therefore, obviously, be designed carefully.

A third way to deal with the hypothetical bias problem is to make uncertainty adjustments. This typically means that respondents are asked how certain they are about their answer to the valuation question. This yields a measure of uncertainty of the respondent's answers and this can be used to estimate a better WTP measure, for example by recoding uncertain 'yes' answers to 'no' answers. This assumes that respondents that are uncertain about their 'yes' in a hypothetical situation will choose 'no' in a real setting. This assumption may not be too unrealistic. The method does seem (somewhat) arbitrary, however, and it will obviously have an effect, since any method that reduces the number of 'yes' answers in favour of 'no' answers (up to a certain level) would find a reduction in hypothetical bias.

Concluding, hypothetical bias is a problem that should be addressed. A number of solutions have been proposed and used in the empirical literature, some being more successful than others. Over time, it seems to be the case that the hypothetical bias problem is better and better resolved by developing the existing methods. What is still missing, however, is a good insight into the causes of the bias. This is needed to find a structural solution to the problem. But, again, it should be emphasized that current methods are able to reduce or eliminate the bias more and more, as long as they are used carefully and cautiously.

3.5.3 CVM and economic theory

Apart from hypothetical bias, the so–called "embedding effect" is a potential problem for CV studies. The embedding effect is the tendency of some contingent valuation survey responses to be similar across different survey questions, in conflict with theories about what is valued in the utility function. There are three underlying effects that could cause this to occur: the (lack of) scope problem, the sequencing effect and the subadditivity effect (Hanemann, 1994).

The (lack of) scope effect implies that the WTP varies inadequately with changes in the scale or scope of the item being valued. If the stated values are fairly insensitive to changes in the size of the project to be valued (restoring one lake, or a set of ten lakes), this is consistent with the presence of a so–called 'warm glow effect', i.e. people simply expressing their concern for the environment by giving a WTP value, without adjusting it to the 'amount of environment' to be valued (Diamond and Hausman, 1994). The sequencing effect refers to the phenomenon that when asking respondents to value a specific lake in a questionnaire in which the value of several lakes need to be assessed, the valuation of this particular lake depends on whether it is the first item to be valued, the second or the tenth. Finally, the subadditivity effect refers to the phenomenon that the WTP for a set of public goods may be less than the sum of the WTPs for the individual changes separately. That is, the sum of the WTPs for lake A (obtained from one group of respondents) and for lake B (obtained from a second group) is larger than the WTP (obtained from a third group) for restoring two lakes A and B simultaneously.

But why would these effects be present in CV studies? And do they make (economic) sense? In other words, should we expect that goods always have the same value, irrespective of the context in which they are being valued –that is when they are valued individually, or in a sequence of valuation questions regarding other lakes as well? If so, the presence of subadditivity and sequence effects and the absence of a scope effect may force us to conclude that indeed CV is not a reliable method of obtaining WTP and WTA.

Indeed, opponents of CVM use these three phenomena to make the case that this method is unable to provide reliable estimates. Diamond and Hausman (1994) simply say that the phenomena occur in CV studies because the method does not really measure people's preferences. Rather, CV studies may be measuring warm glow. It may also be the case that individuals are describing what they think is good for the country, as some sort of cost–benefit analysis. Rather than just assessing the benefits a certain project would yield, they first infer whether the project should be implemented ('do the benefits exceed costs?'), and then they try to estimate the costs of the project ('if all citizens in the Netherlands chip in, the costs per household need not be that high'). It could also be that people give a monetary value simply because they are asked to give a monetary value. If one or more of these hypotheses are true, this would mean that CV valuations are useless for measuring use and non–use values of environmental amenities.

The view that CV studies are not measuring preferences is opposed by Hanemann (1994). With respect to the scope effect, he refers to the empirical literature that generally seems to find a variation in valuation with scope. Sensitivity to scope can be tested internally, by asking the same subjects to value a nested sequence of goods, or externally, by asking different subjects to value different levels of public good provision. Using the latter approach, Carson (1994) finds that in 25 of 27 reviewed papers scope significantly affects WTP, and he criticizes the other two studies for (i) using open–ended WTP questions (instead of using other formats) and (ii) using as subjects shoppers at a mall (rather than doing personal interviews at home, so that subjects are more inclined to give considerate answers).[9] More studies confirm that scope significantly affects valuation. Carson et al. (1996) refer to a Southern Californian survey, which finds that people's WTP for a recovery plan of four species with reproductive problems is higher than when two species are considered. Kartman et al. (1996) find in a contingent valuation study in health care that respondents are willing to pay more for more effective medicines, but one should realize that this study does not consider a public good. In estimating the people's WTP for a clean up of a river in Sapporo, Takeshita (2005) explicitly tries to control for the warm glow effect. In doing so, Takeshita tries to separate warm glow from project–specific WTP. He asks respondents for their WTP for improving the quality of a nearby river. And he measures warm glow by asking all respondents what their WTP is when viewing the clean up as just a 'good social project'. The difference between the two WTPs is then interpreted as the 'project–specific' WTP. He finds that this 'project–specific' WTP is sensitive to scope, but the 'warm glow' WTP is not. There is, however, also proof to the contrary. Lindberg et al. (1997), for example, find a lack of scope: people in Oregon are not willing to pay more for a 50% reduction in traffic congestion than for a 25% reduction.

This list of studies can be extended, both with studies confirming the scope effect and studies rejecting it. Boyle (2003) concludes that WTPs and WTAs in CV studies are sensitive to scope when use values are measured, but not always when non–use values are solicited. It is difficult to say what this means for the reliability of CVM, since many studies that fail to find scope sensitivity are criticized for the survey design. Maybe Bishop's (2003) notion is useful here: "reviewers of a [contingent valuation] study would normally take passing a scope test as evidence of [the study being valid in that it yields results consistent with economic theory]; not passing raises questions that may lead to doubts about [such] validity. However, it is also possible that there are good or at least plausible explanations for the failure." Thus, a scope test may hint at the quality of a contingent valuation study, but the fact that the scope effect is absent in some studies is no reason to reject the CV method itself.

With respect to sequence effect, the fact that the value respondents place on an environmental good presented in a nested sequence (that is, in a series of public goods to be valued) often depends on the order of presentation, may be due to substitution and income effects. That is, if two lakes are substitutes, cleaning up one lake reduces the value attached to cleaning up the other. And, if money is spent on cleaning up one lake, less income is left and thus WTP to clean up the second lake should be lower. Context obviously matters here. If respondents are not informed about the existence of other lakes (or about whether they are cleaned up too or remain in a poor state), their valuation is likely to be affected. For example, Bateman et al. (2004) show the importance of presenting all valuation questions in advance. If

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[9] Interestingly, these two particular studies are cited by Diamond and Hausman (1994) as a proof that sensitivity to scope is absent in CVM studies.

people know in advance which (levels of) environmental amenities they will be asked to value, scope sensitivity is found to be significant and, furthermore, the order of the valuation questions does not matter. However, if people do not know this in advance, and hence may be 'surprised' by a second and even third valuation question, the ordering of questions (either top–down or bottom–up) influences the value estimates that are found. Indeed, they may have spent 'too much' on the first public good project because they did not know of the existence of the second project.

In addition to properly informing respondents, it is also important whether the projects are presented as 'either/or' or as 'and/and'. In the same study, Bateman et al. (2004) distinguish between using an inclusive list and using an exclusive list for presenting different projects. In inclusive lists, each subsequent good is presented as an addition to goods already presented and valued. In contrast, in exclusive lists, each good is presented as a mutually exclusive alternative to any other good presented. While substitution and income effects imply that the valuation of a good from an inclusive list should depend on sequence, these effects are controlled for in valuation from an exclusive list. Thus, the way the valuation questions are addressed is expected to influence the estimated value. That is why Bateman et al. conducted their study for scope and sequence effects using an exclusive list, indeed finding no proof of sequence effects.

So, Bateman et al. conclude that sequence effects are a result of not making visible in advance the different levels of amenities respondents have to value. Clark and Friesen (2005), on the other hand, find that the sequence effect may be a robust phenomenon, but one that is not related to just public goods as such, since they find the effect for a private good as well. Furthermore, accounting for the warm glow effect has no effect on the strength of the sequence effect. Finally, they do not find that sequence effects influence the degree to which valuations are sensitive to scope. It thus seems that the sequence effect can largely be addressed through the survey design, i.e. by showing in advance the valuation questions, but also that it even may not be that much of a problem for CV studies, since the sequence effect is encountered for private goods as well.

Finally, we address the question whether the total WTP for a set of public good projects is less than the sum of the individual valuations, the subadditivity effect. The test is as follows: ask one group of people to value public good X, inform a second group that X will be provided and ask them to value public good Y, and ask a third group to value X plus Y simultaneously. Typically, the result of this exercise is that the sum of the valuations of the first two groups is higher than the amount stated by the third group.

Again, income and substitution effects may be responsible for this disparity. The income effect is as follows: if people have spent income on one environmental amenity (the third group), they have less money left to spend on a second. Hence, when people are asked to value two amenities together the total WTP should be lower than the sum of WTPs when different groups of subjects are asked to value the one or the other. But income effects are likely to be relatively minor here (as the sums of money involved are relatively small), so difference is expected to be small. This is, however, not always the case; the disparity can be quite large in practice. For example, Diamond et al. (1993) find, when estimating WTP to prevent logging in particular wilderness areas, that the difference is quite large indeed.

But substitution effects may also be at work here; people are expected to be willing to pay less for a public good or environmental amenity if another amenity already has been offered. Hanemann (1994) states that the substitution effect and diminishing marginal rates of substitution are enough to explain the subadditivity effect. He gives a theoretical consideration of his idea, but no empirical results.

Overviewing the literature, we conclude that there are sound economic reasons why subadditivity and sequence effects may be present in CV studies. If they are very large or if there is a lack of scope, the underlying cause is often a faulty survey design. Therefore, the survey should be designed carefully. For example, using a top–down series of WTP valuation questions, without informing people in advance about this procedure, is not a good idea. Also, attention should be paid to using a representative sample of respondents, obviously. So, using respondents which are interviewed at malls or which are recruited via Internet may be problematic. But it seems fair to conclude that well–designed CV studies are able to pass all these three tests; the presence of subadditivity and sequence effects or the absence of a scope effect are good reasons to doubt the validity of individual CV studies, but are not a reason to discard CV as an invalid method.

3.5.3 Increasing the reliability of the CVM

Over the past two decades a substantial amount of research has been done on how to increase the reliability of Contingent Valuation, apart from addressing hypothetical bias. The following guidelines have been established:

1. Using in–person or webcam–based interviews, and not convenience sampling at the supermarket.
2. Pose the valuation question in a referendum format ("Are you willing to pay €10, yes or no") and vary the number between individuals rather than asking open–ended questions ("How much are you maximally willing to pay").
3. Emphasize the consequences of the respondent's answer.
4. Always ask follow–up questions to detect protest bids, motivations behind the reply given, etc.
5. Use WTP questions, and not WTA questions.

This list is not exhaustive, but it does contain the most important do's and don'ts. Regarding the first, the information provided is the most important determinant of the value obtained; if the respondent does not get all information, mishears it etc, the stated valuation is going to be incorrect. Therefore respondents should be interviewed in a quiet area, preferably in their homes, and by having in–person interviews or interviews via webcams (rather than by telephone) the interviewer can check whether the respondent has understood all information etc.

Regarding the referendum format versus the open–ended question: this is a key insight obtained from previous experience with the technique. Actually constructing one's preferences (and even trying to find the indifference point, the *maximum* WTP/*minimum* WTA) is very difficult indeed. But the question whether one is willing to pay €10 so that the seals in the Waddenzee do not go extinct, is very easy to answer for most of us. Indeed, this format resembles referenda we have some experience with, and it also resembles our daily purchasing behavior in the supermarket (a carton of milk sells for €0.90; take it or leave it). And by proposing different numbers to different people, one is able to actually trace a demand function (as the percentage of subjects rejecting the offer is likely to go up if the bid price is increased).

The third and fourth are essential ingredients to any CVM to ensure that people think carefully about the question they are asked to answer, and also to give insight into whether the subject's bid is for example zero because he/she does not value the good at all, or because he/she thinks that the good itself is valuable but that he/she cannot be asked to pay for the good. This may be relevant in case of for example the Exxon Valdez, people positively valuing the Alaskan nature area but rejecting the idea that they need to pay for the clean up.

The fifth regarding WTA vs WTP questions is a little bit more subtle. First of all, it may be expected that it does not really matter whether one asks a WTP or a WTA question. Indeed, asking someone's WTP to obtain a benefit or that person's WTA if the benefit does not go through are indeed different sides of the same coin, except that in the first case one ends up a little bit poorer and in the second a little bit richer. That means that there may be a (typically small) income effect affecting WTA and WTP, implying that WTA is expected to be slightly larger than WTP. This should definitely hold for marketed goods, and is expected to be relevant for public goods as well (although the theory is not unambiguous on this).

The theory on loss aversion, however, refutes this neoclassical prediction at least to some extent. Indeed, ownership of a good is found to affect a subject's valuation of the good (cf. Kahneman et al. 1990). Remember the times that you and your sibling were given toys by your parents; a red Dinky Toy and a green Dinky Toy. Ex ante you may not have had a clear preference for getting the red or the green one, but as soon as you were given either the red or the green one, you were unwilling to swap it with your sibling. This phenomenon is well known now in the valuation literature, and indeed WTA (having ownership, being asked how much to receive to give it up) is often many times larger than WTP (no ownership, being asked how much you want to pay to obtain ownership).

If there is indeed a large difference between WTP and WTA the policy maker may face difficult decisions. Suppose that for a project both values have been elicited, and that the investment costs are larger than the WTP value but smaller than the WTA value? One solution is to decide whether one thinks that society is entitled to the project, yes or no. In case of yes, WTA is the appropriate concept, if no, WTP questions should be asked.

But even then researchers tend to prefer WTP questions rather than WTA questions. One reason is that WTP helps identifying strategic bids (people stating a WTP of 10 times their annual income are likely to behave strategically, whereas a WTA of 5 times one's annual income may well be the correct number). The second reason is that usually people are less upset when asked to answer a WTP question than a WTA question. For example, it is easier to answer the question "how much are you willing to pay to prevent the seals in the Waddenzee from going extinct" than the question "how much do you wish to receive if we let the seals in the Waddenzee go extinct". Both strategic responses and protest bids can affect the mean WTP or WTA considerably. If 99% of the population states a WTA of 10 euro's whereas 1% states a WTA of 10,000 euro's, the mean WTA is 100 euro's. If the response of the 1% can be viewed as protest bids or strategic overbids, they should be omitted from the calculation of the mean WTA, and the SCBA's conclusion would be that society's WTA is 10 euro's. In this case it is easy to detect 'invalid' bids, but in actual SCBAs it may be less clear what bids are effectively protest of strategic bids, and which ones are 'valid' bids. Because of that reason, WTA or WTP is obtained using the *median* WTA or WTP (or, that value for which 50% of the population would agree to pay or accept that amount, and 50% not).

3.6 Conclusion

Overviewing the current state of the valuation literature, it is undeniable that it made huge progress since the early applications and also its policy relevance has increased over time. Revealed preference methods are widely applied and are considered reliable in providing lower–bound estimates of people's valuation of public goods such as environmental quality. And despite the amount of flak CVM has received (see for example Diamond and Hausman 1994), the method is still being applied for both scientific and policy purposes, and it is being refined over time. And it seems that the method's acceptability in both scientific and policy

circles has increased too, especially also because it is essentially the only method to measure non–use values.

One disadvantage of valuation studies is that they are quite expensive to implement. This gives rise to a next level of cost–benefit analysis: is it worth our time and money to undertake an SCBA? Obviously, the costs of SCBAs can be decreased by using information from previous valuation studies (known in the literature as benefit transfer), but this always raises the question to what extent benefits obtained in one region are transferable to other regions. And this issue is still under debate.

That means that the question of whether it is worth pursuing an SCBA is a relevant one, and the answer is that SCBAs (from an economist's point of view) should be implemented if the probability is sufficiently large that the outcome of the SCBA will change the policy decision from 'go' to 'no go', or vice versa.

4. Discounting and risk

4.1 Introduction

Since the costs and benefits of environmental goods and services usually have a time dimension, the question arises whether the future should be discounted or not and, if so, at what rate. Nothing exerts greater influence on the results of long–term assessments and cost–benefit analyses than the rate at which we discount future benefits and costs. The general idea is that when somebody owes you money and offers you to pay back in a year's time rather than tomorrow, you tend to think that receiving €1000 tomorrow is generally preferable to receiving that amount in a year's time. One reason is that if you put €1000 in a bank account yielding 5% interest, you have €1050 rather than just €1000 in a year's time. And reasoning backward, if somebody actually owes you €1000 in a year from now, you are willing to accept getting just €952 today (=1000/1.05). Similar considerations may or may not hold for government decisions regarding investments in environmental goods and services. But it is clear that *if* the government decides to discount future benefits and flows at a positive discount rate, the consequences of choosing a particular level are substantial. This is illustrated in figure 4.1, which shows the present value of receiving €1000 at different future dates at different discount rates. For discount rates that do not look excessively high it already follows that we practically ignore the remote future.

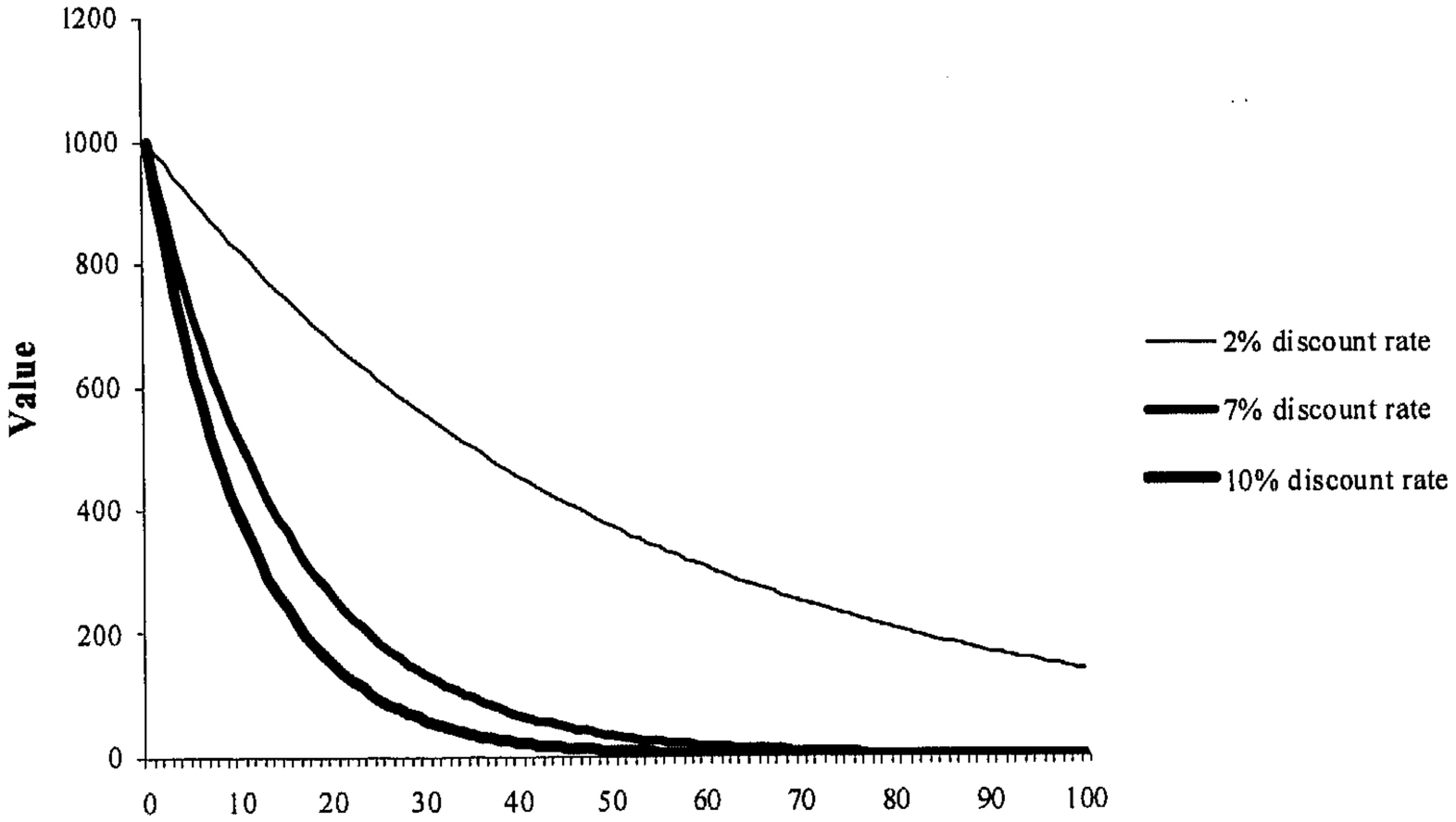
In this section we will discuss what determinants affect the size of the discount rate. Or, in other words, what determines the relative value of a project's (uncertain) future returns to the setup (or investment) costs incurred today. Spending a moment thinking about the relevant factors, clearly future wealth plays an important role. If nature is a luxury good, we will value it more the richer we end up, and hence the discount rate will be lower (we should be more patient, as we will explain later in more detail). But our future wealth crucially depends on the discount rate too: the lower we set our discount rate, the more we are willing to give up current consumption for higher future returns, and hence the more likely we are to invest in capital goods, R&D, etc, and hence the more wealthy we will be in the future. That means that future wealth is a determinant of the discount rate used, but the discount rate used also affects our future wealth.

This is a key problem in discounting. The implication is that, strictly speaking, the concept of "the correct discount rate" is relevant for fairly small projects only, i.e. those projects that do not (substantially) affect the (future) state of the economy. For example, it is a concept that is more applicable to valuing whether or not we should sacrifice a park in the city centre to be able to build more houses than to a project with large economy–wide consequences such as global warming. The latter can only be evaluated properly if large economic models are built that are used to calculate the short and long run impacts of the project. Given the daunting nature of such an enterprise, people often defend using the 'short–cut' of simply fixing the discount rate taking economic growth (and a host of other factors) as given, and then apply sensitivity analyses to the policy conclusions thus obtained.

In this chapter we take the short–cut approach too. The setup is as follows. We start by explaining the rationale for discounting by the government using the analogy of discounting by private agents. In section 4.2 we draw from the analogy of consumer behaviour to explaining discounting, in section 4.3 we draw on the analogy of firm's investment behaviour in order to explain the role of risk. In section 4.4 we address how governments view discounting. In section 4.5 we discuss how risk premia can be included in the social discount rate, and 4.6

deals with the impact of the introduction of new information. In section 4.7 we argue, that including risk premia in the social discount rate may not be the proper method of coping with risk; higher risk does not always decrease the value of (environmental) projects, and hence just adding a risk premium to the discount rate may result in the government making the wrong decisions. We argue that the type of risk should be carefully classified and that uncertainty can be addressed by various scenarios, which should be discounted at the risk–free social discount rate. Then, in section 4.7 we explain what the factors are that determine the level of the risk–free discount rate applied in social cost benefit analyses, and put numbers to it. All these sections are based on essentially a very simple model in which there is uncertainty regarding various items to be valued, but not regarding the discount rate itself. We drop this assumption in section 4.8 and show the consequences of having multiple discount rates. In section 4.9 we drop another simplifying assumption, which is that the good to be valued is a composite good with fixed weights. We explain the consequences of valuing individual goods (rather than a composite one), focusing on the consequences of changes in the relative value of the various components (and hence allowing relative weights to change). Finally, we draw conclusions in section 4.10.

Figure 4.1: The impact of discounting at different rates on the net present value of €1000.



4.2 Private discounting

There is a close relationship between people's private consumer discount rates and the market interest rate. Consumers value future consumption possibilities taking into account (i) that one generally prefers current consumption to future consumption (if only because one

may die prematurely), (ii) that one's income may be increasing or decreasing over time, and (iii) that the more one consumes, the smaller the *extra utility* one obtains from consuming an extra unit of consumption goods. Point (i) makes intuitive sense; points (ii) and (iii) simply imply that if you expect to be very rich in the future anyway, you are less inclined to save today. This is captured in the famous Keynes–Ramsey equation, where the private consumption discount rate (r_p) is determined as follows:

$$rp = \rho p + \mu p g p \qquad (4.1)$$

where ρp is an individual's *pure* rate of time preference (determined by sheer impatience, or by the probability of dying in the next period), μp is the income elasticity of marginal utility of consumption (measuring how much an extra unit of consumption is worth to the individual), and g_p is the growth rate of consumption. Note that a key assumption here is that we discount the entire bundle of all available consumption goods, including the benefits of environmental protection etc. Changes in the amount of consumption in terms of this 'representative' consumption good then indexes how individual components of this bundle should be discounted, assuming away relative price changes etc. Obviously, this is a limitation, which will be remedied in section 4.7.

Maintaining the assumption that a representative bundle of consumption goods can be constructed, the implication of (4.1) is that indeed the market interest rate is reflective of the rate at which individuals discount the future. The reason is as follows. The terms ρp and μpgp fix the supply of capital (i.e., savings), and firms invest this capital up to the point where the marginal productivity of capital is equal to its cost. Thus, the market for capital clears, and the resulting risk–free market rate of interest (r) is equal to the private consumption discount rate: $r = r$p.[10] And hence the discount *factor* can be calculated based on *observed behavior* (the market interest rate):

$$d(t)=\frac{1}{(1+r)^t} \qquad (4.2)$$

Thus, in an economy with complete markets and without distortions the market rates will be the same as the –properly weighted– rate at which consumers discount the future.[11]

It follows that the risk–free market interest should be taken as a serious indicator of the discount rate when evaluating projects. This seems to make even more sense since usually good data on the market interest rate are available. Note, however, that we do not have complete markets without distortions and that we do not have data on *future* market interest rates. This implies that especially for (very) long–term projects (and this is often the case for envi-

[10] It should be noted that, if consumers differ with respect to their pure rate of time preference, their future income prospects, etc., individual discount rates differ.

[11] If there are distortions (for example capital taxes), the relation between the market interest rate r and the private consumer discount rate can be formalized by $r = r_p + w$ where w is the wedge caused by tax and other obstacles to market clearing (Cline 1999). Given a positive wedge, the private consumer discount rate is below the market interest rate (resulting in firms investing less than they would otherwise do).

ronmental issues) we need to look at the other side of the capital market as well. Moreover, *private* consumer discount rates cannot directly be used for *government* SCBAs.

Before going into details, it may be interesting to look at the consequences of applying the current market interest rate (about 4%) to discounting over a 200–year time horizon. The general picture has been sketched already by figure 4.1, but a numerical example may be illustrative here. A one–time policy action that delivers benefits of 1 million euros in 200 years should, when simply looking at the net present discounted value, only be undertaken if its costs are below 392 euros today, assuming the 4% discount rate. Costs and benefits in the far future easily appear as insignificant present values if the future is discounted at the market interest rate. Hence, actions that cost money now but will benefit future generations are likely not to be undertaken as a consequence of discounting in an SCBA. This appears to be inconsistent with the notion of intergenerational fairness.

Having concluded that the market interest rate is reflective –albeit imperfect– of the rate at which consumers discount future income and consumption flows, the question arises to what extent *risk* has been accounted for. Risk is generally thought to result in higher discount rates, and it is often argued that indeed a risk premium should be added to the (risk–free) market interest rate to account for risk. Before considering this question, it is important to note that two types of risk are *already* present in equation (4.1). The first is the pure rate of time preference parameter, ρ_p. This parameter can be interpreted as the probability of the individual dying in the near future, inducing her to shift consumption to the present and to attach less value to future money or consumption flows than if she would live forever. The second is less apparent from (4.1), but is closely related to $\mu_p g_p$. Recall that g_p is the growth rate of consumption, while μ_p reflects how much an extra unit of consumption is worth to the individual. This second parameter is related to the curvature of the utility function: having more consumption goods at one's disposal is always better, but the extra utility associated with an extra unit of consumption is smaller the more goods one consumes. More pizza is preferred to having less pizza, but once one has eaten two pizzas, the third yields less extra satisfaction than the first one consumed. But if this parameter captures 'decreasing marginal utility', it also captures risk preferences. Suppose an individual has two pizzas, but is forced to flip a coin to decide whether she receives a third pizza, or whether she has to give up one of the two she owns. Clearly, if she wins the third, she will have higher welfare (she has more to eat, or she can eat a more varied meal if the pizzas are of different flavors). But the gain in welfare is clearly smaller (in absolute terms) than the loss she experiences if the coin comes up such that she has to give back one pizza, leaving her with just one pizza to eat. Clearly, risk aversion plays a role here, and the individual's risk preferences are captured by (or reflected by) μ_p.

So, from the risk free interest rate we can infer something about both a specific type of risk (the probability of dying) as well as about individuals' risk preferences. This is insightful, but does not yet tell us how the government should evaluate environmental projects. Before addressing that, we need to discuss first how the *private sector* evaluates investment projects, because this provides insights in how to cope with risk and uncertainty.

4.3 Project evaluation by firms: the roles of risk and the market interest rate

Many large companies use as a decision rule for their investments that the rate of return on an investment project should be at least as large as the market interest rate needed to cover the opportunity cost of putting the money in the bank. In addition, the future profit stream is discounted at a higher rate in order to cover the risks that result from the uncertain conditions in which the firm operates. Decision makers in these firms may be risk averse and may want to reduce the probability that their investments turn out bad. The required rate of return by

firms is usually larger than the risk–free market interest rate, and hence people may think that the same should apply to government decision–making. This conclusion is doubtful, but it gives insight to briefly discuss how firms evaluate projects before returning to the question how the government should discount the future.

Two things are important in the firm's decision–making process. First of all, the firm can always decide not to invest. Then the investment outlays do not have to be incurred, and the firm can invest the available sum of money in a risk–free investment fund (say, government bonds), thus receiving a secure rate of return. Hence, when deciding whether to invest or not, the risk–free rate of interest (r) plays a role.

Second, the riskiness of the investment project plays a role. Here it is important to note that only non–diversifiable risk really matters. Diversifiable risk is risk that can be matched by constructing a portfolio of assets such that any bad outcomes regarding the project are compensated by positive outcomes for other assets. That means that diversifiable risk can indeed be arbitraged away if there are assets in the economy whose returns are negatively correlated with the returns of the project under consideration. That leaves us with non–diversifiable risk. By definition, the larger the portfolio of assets or projects, the smaller its variance. The whole market portfolio provides the maximum available diversification, and any remaining variance cannot be arbitraged away. Therefore, the variance of the market portfolio is non–diversifiable risk. And hence it is the covariance of the rate of return on the investment project with that on the whole market portfolio that determines the required risk premium for that particular project (Dixit and Pindyck, 1994: 116).

Roughly two types of risks can be distinguished. The first is the risk that the project is terminated prematurely because of outside intervention (e.g., a tobacco company contemplating investing in a new plant faces the possibility that the government will ban the production of cigarettes sometime in the future). The second type of risk is variance in the net benefit flow the project will generate. How should the firm treat these risks?

It is not very likely that the 'termination risk' can be diversified away. Hence, termination risk is non–diversifiable risk, and a risk premium is called for.[12] Suppose that the risk–free rate of return is 5% ($r = 0.05$), that there are two periods (this year and the next), that the investment costs (I) of the cigarette plant are incurred this year and that the net revenues next year are either zero (if the firm needs to close, which happens with probability p=0.01) or €X (with probability 1–p=0.99). The net present value of the investment option then is:

$$-I + \frac{1}{1+r}[(1-p)X + p0] = -I + \frac{1}{1.05}[0.99X] \qquad (4.3)$$

That means that the effective discount factor is

$$\frac{0.99}{1.05} = \frac{1}{1.061} \approx \frac{1}{1+r+p} \quad ;$$

hence, the effective discount rate is approximately $r + p$. This is just an illustration and therefore there is a 0.001 'measurement' error (0.061 versus 0.060), but it is not difficult to

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[12] This is not necessarily true. The tobacco company can contemplate investing in plants to produce nicotine pads. Also, sometimes it is possible to create futures markets which allow for diversification; think of Joep van den Nieuwenhuyzen's Begaclaim.

show that the relationship is exact if we consider smaller time periods. Key is here that if the probability of termination is non–diversifiable, it can be accounted for by augmenting the risk–free interest rate with that probability (Dixit and Pindyck, 1994: 114).

Regarding the second type of risk, the risk premium required depends on (i) the market price of risk (Z), (ii) the variance of the project's net benefit flow (σ), and (iii) the extent to which the project's payoffs are positively or negatively correlated to those of the market portfolio (as measured by the correlation coefficient φ, which may thus be positive or negative). The appropriate discount rate is then equal to $r + Z\sigma\varphi$. Indeed, this is the outcome of the (in) famous Capital Asset Pricing Model (CAPM; see Dixit and Pindyck, 1994: 115). Hence, if the project's payoffs are positively correlated with the market portfolio ($\varphi > 0$), risk cannot be diversified away and a risk premium of $Z\sigma\varphi$ is called for.

4.4 Discounting by the government

So how does this relate to the government's problem? Let us start from the ethical position that the government values the welfare of the current and all future generations equally (but see Weitzman 2007). Then the objective is to maximize the sum of welfare of all these generations. But analogous to the tobacco firm, the government also faces 'termination risks'. A meteorite may hit the Earth, causing mankind to go extinct (like the dinosaurs before us; H.M. Treasury, 2003).[13] Or, in the case of investments to reduce emissions of greenhouse gases, there may be a very small probability that global warming is not anthropogenic after all, so that these investments do not yield any net benefits. Let us use ρ_s to denote this (very small) probability. Using u_i to denote the level of welfare obtained by generation i, we have the following function:

$$\text{Max } W = u_0 + \frac{u_1}{1+\rho_s} + \frac{u_2}{(1+\rho_s)^2} + \ldots \qquad (4.4)$$

Note that we used the trick of the firms' behavior above that the probability of surviving ($1-\rho_s$) is roughly equal to $1/(1+\rho_s)$. Also note that if $\rho_s = 0$ (the meteorite will never hit Earth, or global warming is anthropogenic for sure), the welfare of all future generations is weighted equally —they all have weight 1. But if $\rho_s > 0$, future generations receive (slightly) less weight than the current generation, and their weight falls the more distant they are in the future.

Taking (4.4) as a starting point, the same considerations apply here as in the case of the private consumer's decision problem (4.1). Future generations may be richer or poorer than the current generation (economic growth, gs, may be positive, or negative), and also decreasing marginal utilities (as captured by μs) will play a role. That means discounting future welfare (the utility of future generations) implies that we can infer the society's consumption discount rate –usually referred to as the social discount rate. And this is in fact equal to

$$rs = \rho s + \mu s g s \qquad (4.5)$$

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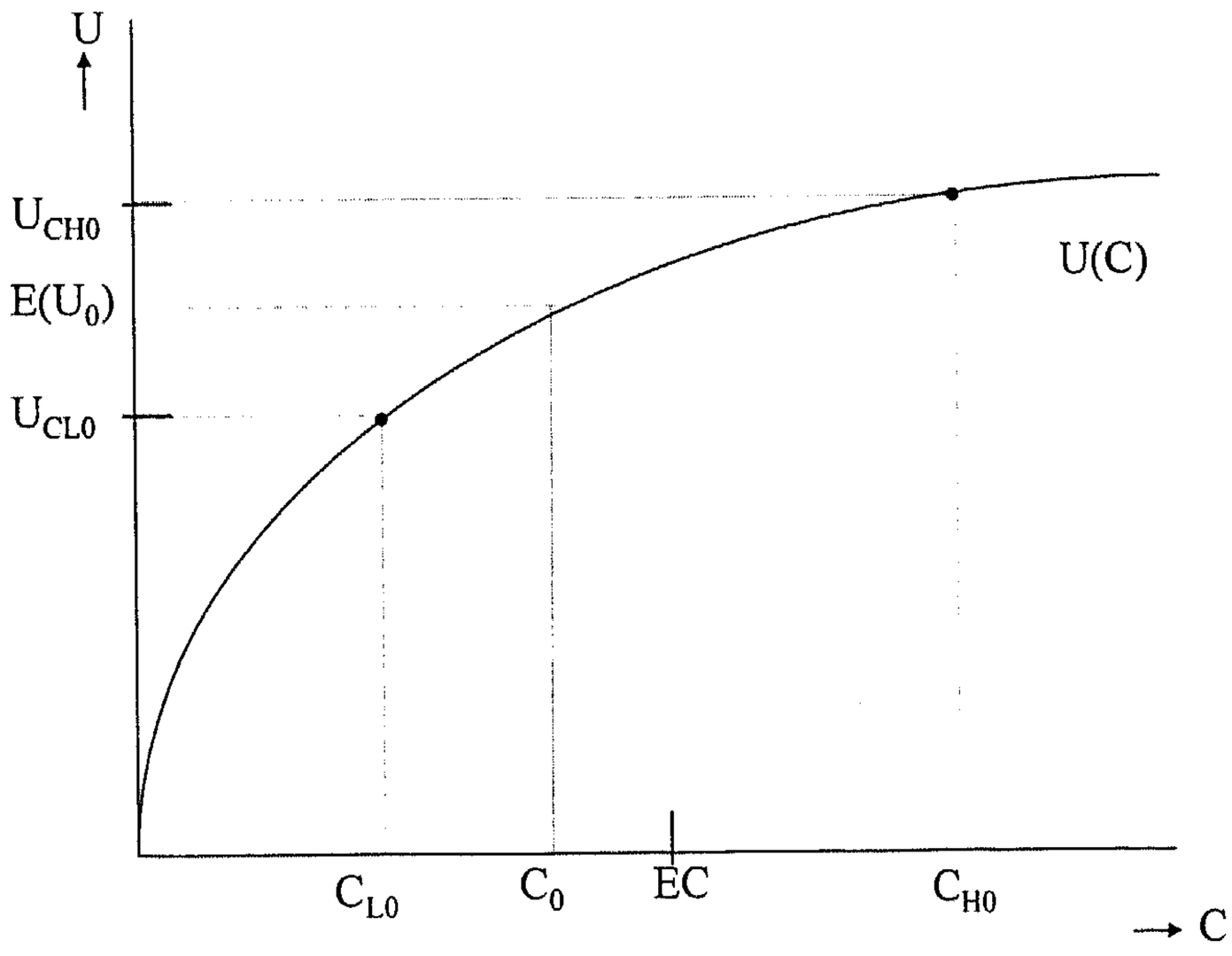
[13] Note that this is similar to the probability of dying of private consumers; see above.

But let us now have a closer look at how (4.5) should be adjusted to capture risk.

The first thing to note is that the returns on investments in environmental projects are uncertain, but also that it is not certain how much richer (or poorer) future generations will be. That means that the social discount rate rs should capture this. Let us think a moment what it means that future income is uncertain. Suppose that *expected* economic growth is gs^* per year, but that it may also be much lower or much higher. To show what that means given that society is risk averse, consider the simplified case. Suppose that at a certain future date, the economy can be in a good shape, or in a bad shape, and that the probability is 50–50. If the economy is in a bad state, the amount of available consumption goods is CL0, and CH0 if the economy is in the good state (with CH0 > CL0). How can we translate the uncertain outcome into a specific value? The case is depicted in Figure 4.2.

Figure 4.2: The welfare consequences of uncertainty with respect to the future state of the economy.



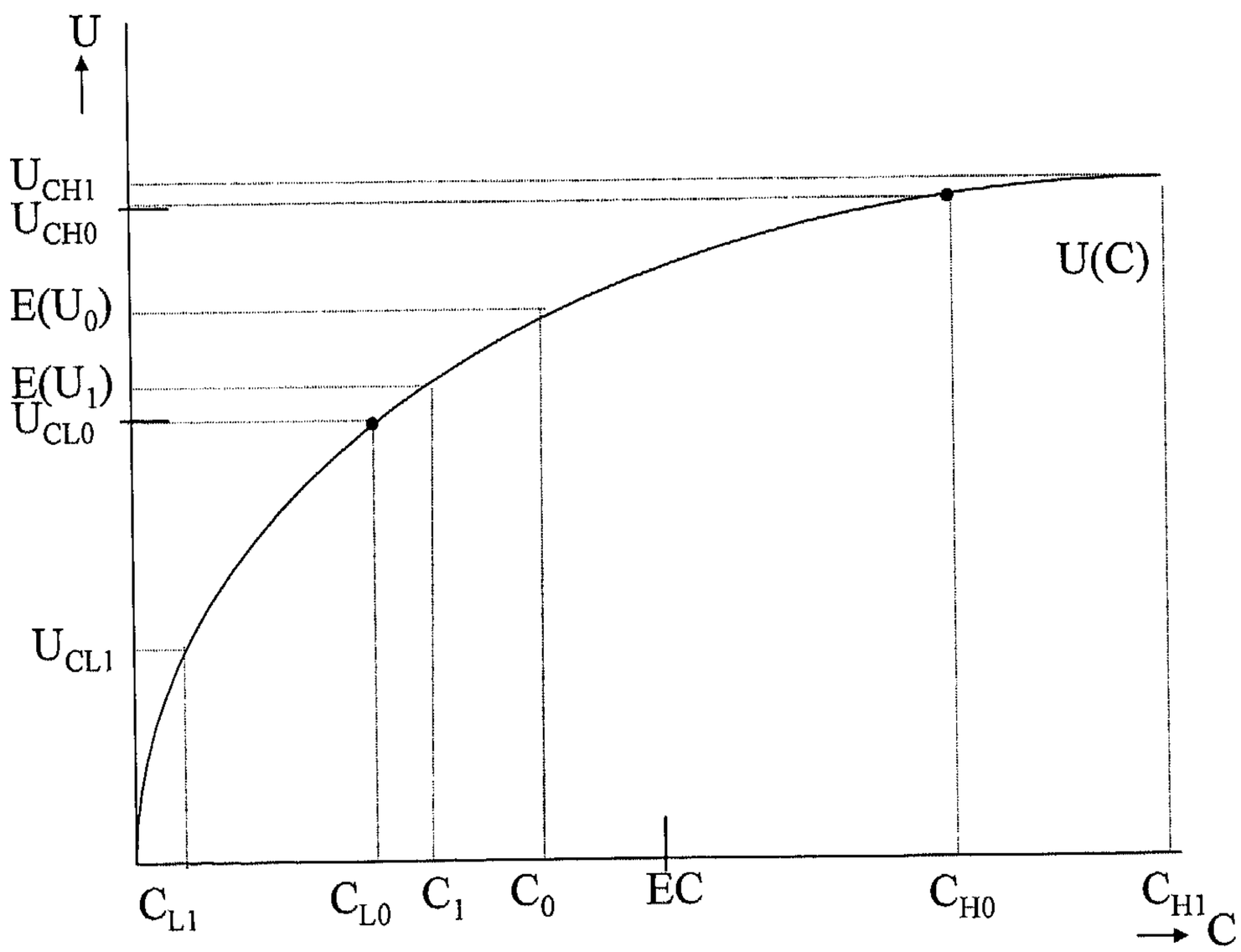
If consumption turns out to be high (CH0), welfare (or utility) equals U(CH0); if consumption turns out to be low (CL0), welfare (or utility) equals U(CL0). Chances for each are 50%, and hence expected utility E(U0) is just the average of U(CL0) and U(CH0). And graphically, E(U0) is exactly in the middle between U(CL0) and U(C_{H0}).

So how do we value this 'gamble' with respect to consumption possibilities CL0 and CH0? One natural measure would be: what is the amount of consumption (C0) that would leave us indifferent between getting that amount, or playing the gamble with a 50% chance of getting CH0, but also with a 50% chance of ending up with just CL0. That amount, C0 is easy

to find in the graph. Expected utility of the gamble is E(U0), and all we need to do is draw a horizontal line and find the level of consumption that yields the same amount of utility. And that is *C*0. And note that this amount is much smaller than the *expected* amount of consumption possibilities, EC, which is just in the middle of *C*L0 and *C*H0. This is not accidental; this is all driven by the fact that society's utility function is curved, displaying risk aversion. If the function would be a straight line, *EC* and *C*0 would coincide.

Now what happens if we increase risk? Consider Figure 4.3, where the expected amount of consumption goods is still EC, but where consumption in the bad state is C_{L1} but consumption in the good state is C_{H1} (note that because EC is kept constant, the graph is drawn such that $C_{H1} - C_{H0} = C_{L0} - C_{L1}$).

Figure 4.3: The welfare consequences of increased uncertainty with respect to the future state of the economy.



Taking the same steps as before, we find that the society would be indifferent between facing the gamble of a 50% chance of getting C_{H1} and a 50% of getting C_{L1}, or just getting C_1 with certainty. Clearly the value of the future economy is lower in case 1 than in case 0; $C_1 < C_0$.

What does this lower value of C_1 in terms of society's willingness to give up current consumption (that is, save more today) to increase future consumption possibilities? Suppose that there is a savings account that yields a secure interest per period. Then clearly we would be more prone to save in case we are facing gamble 1 than if we are facing gamble 0. The welfare levels obtained under both gambles are roughly equal if the state of the economy

turns out to be high; society is then at the flat part of the utility function, and the extra savings do not really increase welfare much. But if the state of the economy turns out to be bad, the extra consumption possibilities are much more valuable in gamble 1 than in gamble 0. Increasing C_{L0} and C_{L1} by an equal amount, the increase is welfare (or utility) is larger in the latter than in the former case.

Having said all this, how should we capture these considerations in equation (4.5)? The new equation is as follows:

$$rs' = \rho s + \mu sgs^* \qquad - 0.5\ \mu s2\sigma 2 \tag{4.6}$$

where gs^* is the expected growth rate (and hence related to EC), and σ the measure of uncertainty (and hence related to $CH0 - CL0$, and to $CH1 - CL1$). The larger the uncertainty with respect to the future state of the economy (σ, or $CHi - CLi$), the higher society's propensity to save, and hence the smaller the social discount rate rs'.

But we are also interested in how to value risks regarding environmental projects. This is discussed in section 4.5

4.5 Scenario's and risk–adjusted discount rates

Let us now show how risk premia for environmental projects should be treated. We have seen above that the risk–adjusted discount rate translates future *uncertain outcomes* (with respect to consumption possibilities) into *equivalent certain* outcomes (consumption amounts), evaluated in present money terms.

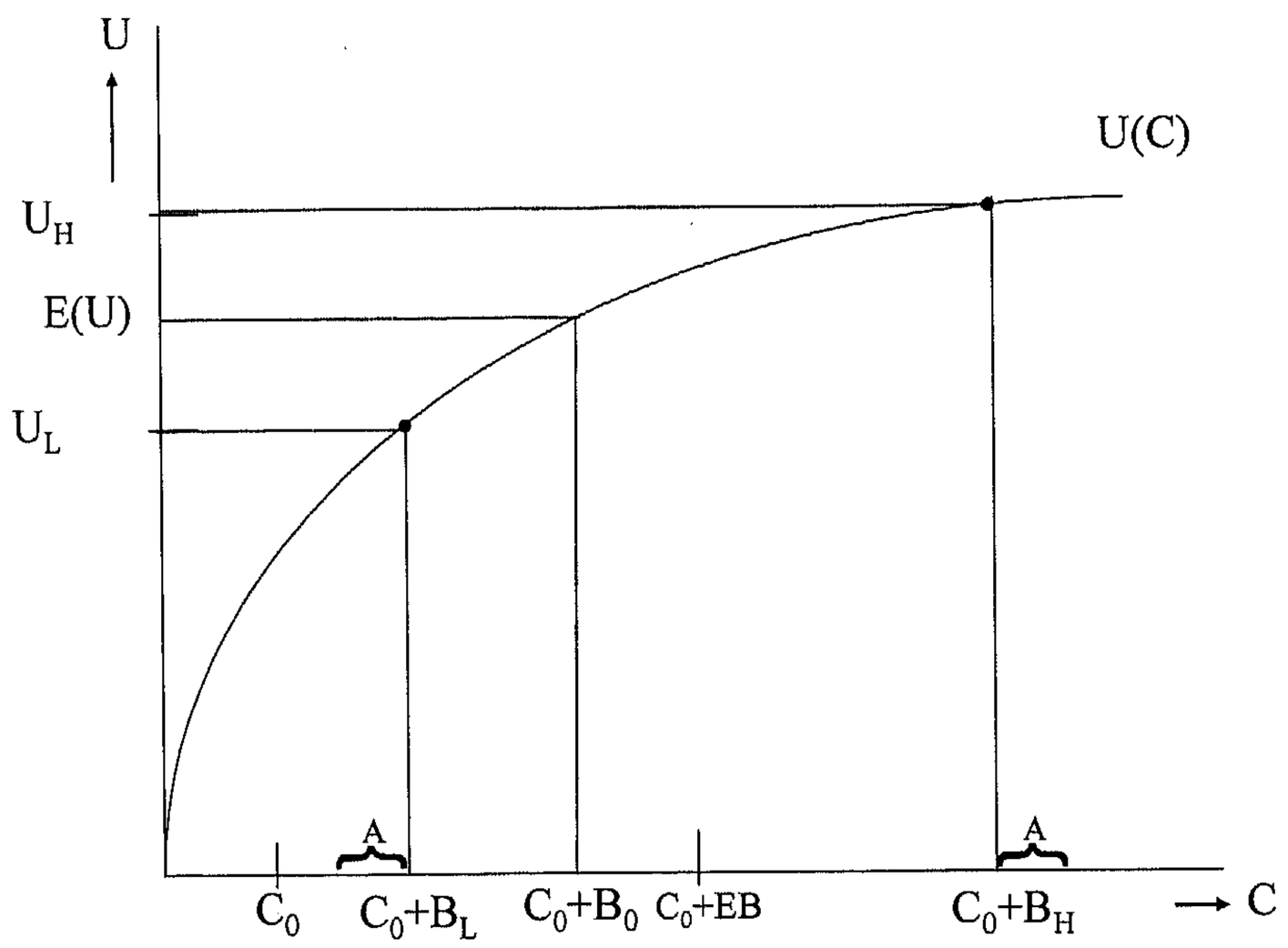
Here, we will not present the exact formulas showing how discount rates should be adjusted to capture project risk (that is, we do not show exactly how (4.6) should be adjusted for specific projects). What we will do is show how uncertainty with respect to the benefits of investments in environmental projects translates into welfare consequences, and how these can be valued in a way very similar as is done in Figures 4.2 and 4.3. Note that risk premia in the discount rate are used to translate future *uncertain outcomes* (with respect to nature, or gambles with respect to consumption possibilities) into *equivalent certain* outcomes, evaluated in present money terms. The *equivalence* means that the individual agent (society) is indifferent between facing the uncertain *gamble* (with respect to nature, or money, or consumption possibilities) and having a *certain* amount of money directly.

Let us suppose that, very mundane, the investment in a nature project only affects consumption possibilities. Say, protecting biodiversity increases agricultural productivity. But it is unclear by how much. Suppose that there is a 50% chance of biodiversity protecting increasing agricultural output (and hence consumption possibilities) by an amount BH, but that there is also a 50% chance of output just increasing by an amount BL (with $B\text{H} > B_L > 0$).

Now let us see what it means here that risk increases. Suppose that there are two uncertain environmental projects. Say that they have the same expected benefit (EB), but that they differ in how uncertain their payoff is. In project 0 there is a 50% chance of increasing consumption possibilities by BH, or 50% of just winning BL (with $B\text{H} > B\text{L} > 0$). In project 1 there is a 50% chance of increasing consumption possibilities by $B\text{H} + A$ and a 50% chance of just increasing consumption by $B\text{L} - A$. Clearly, these two projects have the same expected value ($EB0 = EB1 = 0.5\ B\text{H} + 0.5\ B_L$), but project 1 is more risky than than project 0. The challenge is to value these two projects.

As was the case in the previous section, we now find the amount of consumption goods ($B0$) that would leave us indifferent between getting that amount with certainty, or playing the gamble of the uncertain environmental project 0. In Figure 4.4 we show how $B0$ is determined.

Figure 4.4: Translating the uncertain outcome of nature investments (50% chance of getting BL extra consumption, 50% chance of getting BH extra consumption) into a certainty–equivalent value ($B0$).



In this figure, obtaining an amount BL results in utility level UL (given the current state of the economy, $C0$) and getting BH results in a level of utility equal to UH. Using the 50–50 chance of winning either amount, expected utility E(U) is the weighted average of UH and UL, and hence is in the exact middle of UH and UL. Now the level of money $B0$ (given the individual's initial consumption possibilities, C0) that leaves society indifferent is the amount that would yield the same level of utility as yielded (in expectation) by project 0, and that is $C0 + B0$ as shown in the graph. Hence, the lottery with a 50–50 chance of winning BL or BH has a value of B_0 (given C_0).

So how should uncertain future projects be valued? Should we use a higher or a lower discount rate? The higher the uncertainty with respect to B, the lower the expected utility and hence the lower the value of the lottery. This is easily seen in Figure 4.4. Let us consider the other nature project, project 1. This is captured by moving $C0 + B$L a certain distance to the left (by the amount A) and $C0 + B$H the same distance to the right, the resulting increase in UH is much smaller than the decrease in UL. The larger is A, the lower is expected utility, and hence also the lower the certain equivalent amount of consumption possibilities, B_1 (not shown in the graph).

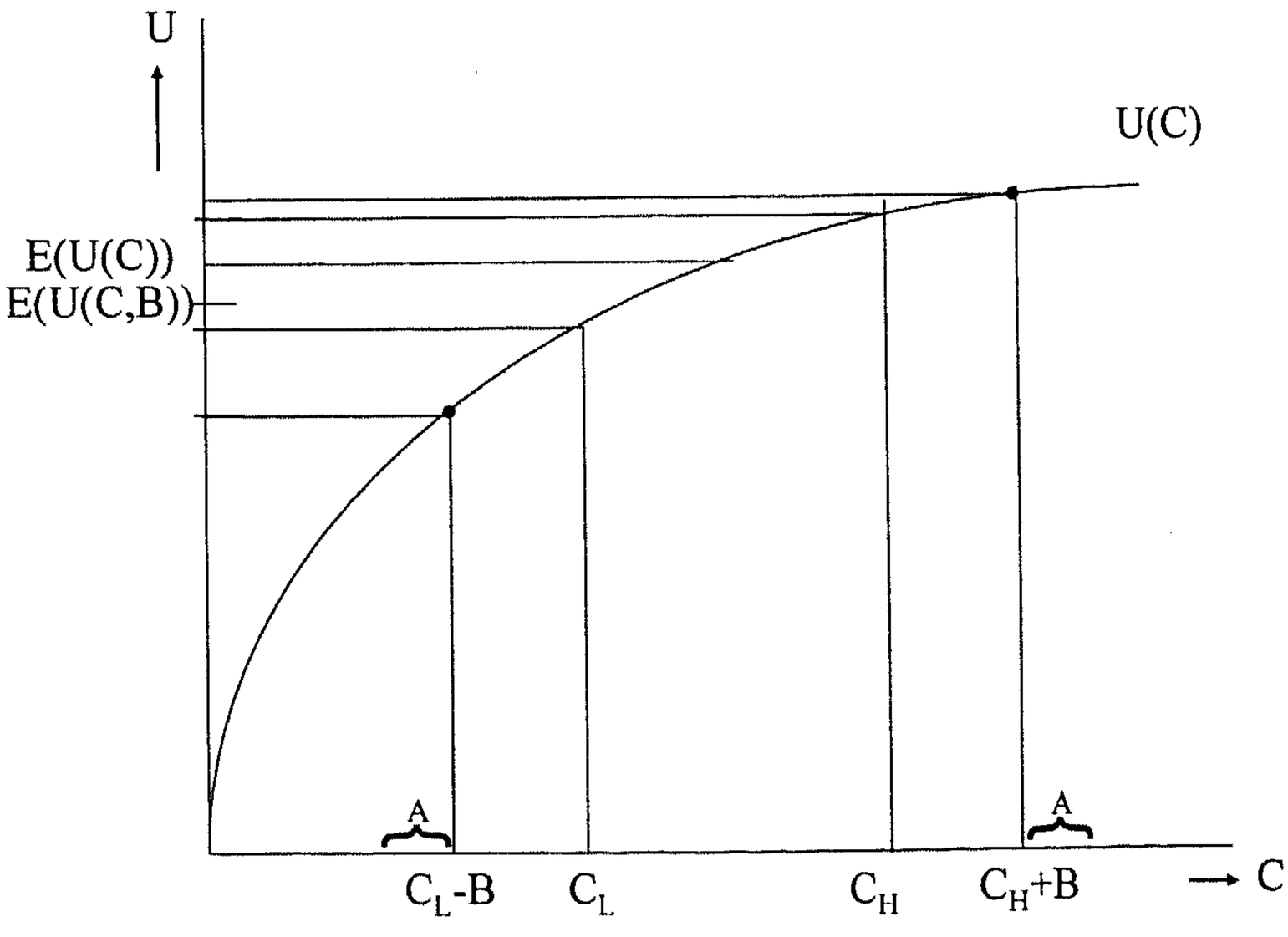
Thus, with the same expected outcome in terms of consumption possibilities (C_0 + 0.5 BH + 0.5 BL), the larger the uncertainty the lower is expected utility, and hence also the value of project. So, this is exactly what the discount factor does; when translating a future uncertain payoffs (or consumption possibilities) with a specific expected value (EB = 0.5 BH + 0.5 BL), it gives the *value* of that uncertain outcome in terms of a money metric; the higher the uncertainty (the higher the spread in BL and B_H), the lower the value of the project and this translates into a higher positive risk premium in the discount rate.

So, although the two projects (BH and BL with 50% chance for each, and BH + A and BL – A with 50% chance for each) have the same expected value, the second is more risky than the second and hence its expected value (0.5 BH + 0.5 B_L) should be discounted at a higher rate.

Clearly the value of the project depends on the amount of initial consumption possibilities; the 'state of the economy' C0. Getting an extra amount of consumption goods (whether it is BL or BH) is less valuable the better the state of the economy, and hence the social discount rate should be higher if we know that the future state of the economy will be good (cf. equation 4.5 or 4.6). But the discount rate should be higher the more risky the project itself is *if its outcome is independent of the state of the economy*. That is basically what we assume here; we assumed that the future state of the economy was known with certainty (C_0), and the outcome of the environmental projects were determined by 'flipping a coin'. So this pertains to small environmental projects, like preserving the 'Haagse Bos' or not.

But what if the project is positively or negatively correlated with the economy, as may be the case with projects like 'combating global warming'? Suppose that the future consumption possibilities (national income) is either high or low, and that there is an environmental project which payoffs are positively correlated with the state of the economy. That means that if the state of the economy is high (CH), the project yields a positive payoff (B), whereas these payoffs are negative (–B) if the state of the economy turns out to be low. Note that the expected benefits of the project are zero in this case. This facilitates the graphical exposition, and yields the same conclusions as when one considers projects with positive (but uncertain) expected benefits.

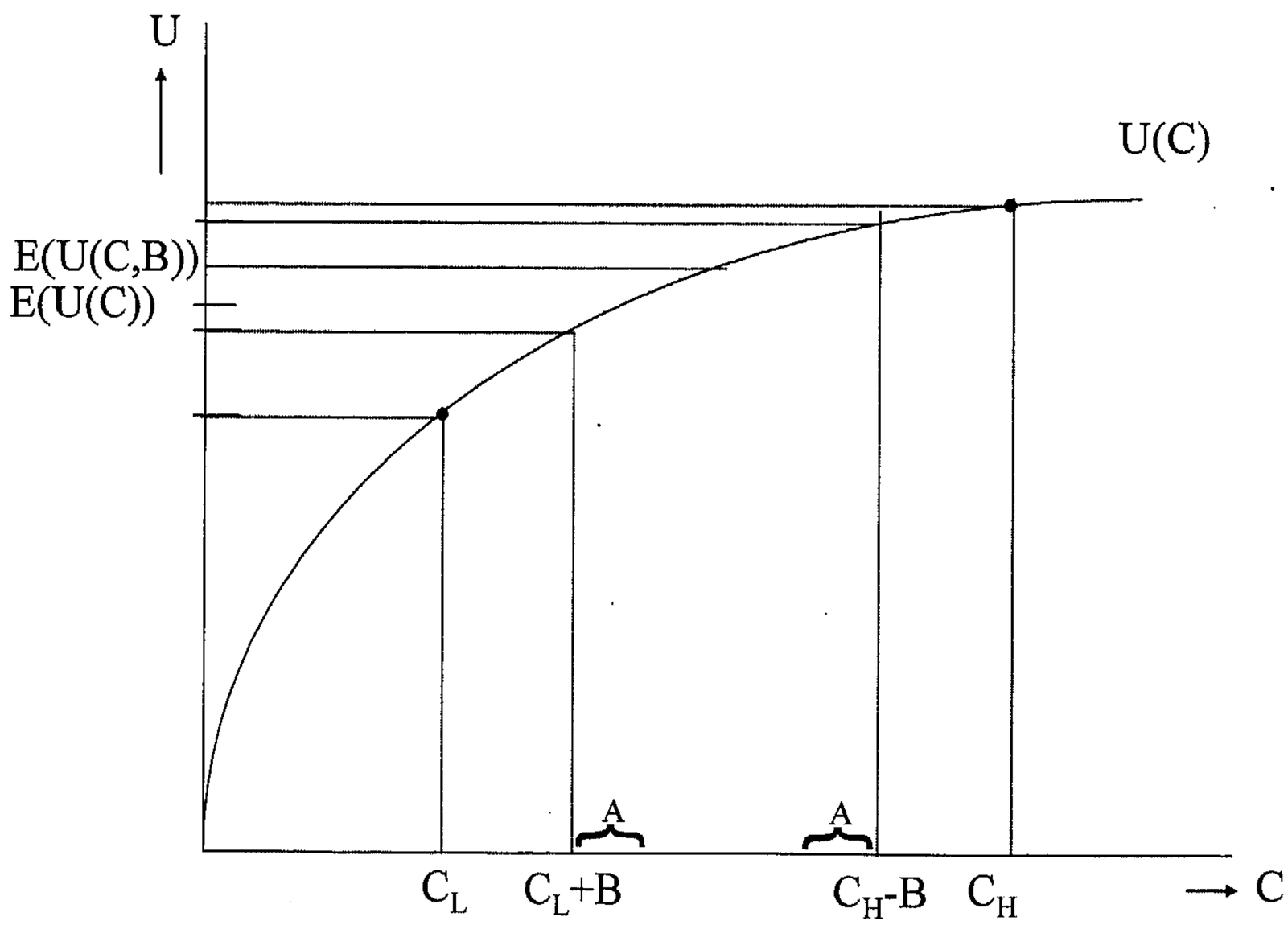
Figure 4.5: Valuing a risky environmental project the returns of which are positively correlated with the state of the economy.



In this case, the expected utility with the uncertain project is lower than the expected utility without the project; given the positive or negative change (B) in consumption possibilities, the project now increases the uncertain range in the state of the economy, increasing it from (CL, CH) to (CL – B, CH + B). Hence, expected utility (or welfare) is lower than without the project. And this is worsened the larger the fluctuations are. Suppose that the change is not B but $A + B$ (increasing the uncertain range to even (CL – B – A, CH + B + A). Then the expected utility is even lower. Hence, if a project's returns are positively correlated with the state of the economy, the more uncertain it is, the lower the project's value and the larger the risk premium in the discount rate.

But now consider the case that where the benefits of the project are negatively correlated with the state of the economy. That means that if the state of the economy is high (CH), the project yields a negative payoff (–B), whereas these payoffs are positive (B) if the state of the economy turns out to be low (CL). This is depicted in Figure 4.6.

Figure 4.6: Valuing a risky environmental project the returns of which are negatively correlated with the state of the economy.



In this case, the expected utility with the uncertain project is *higher* than the expected utility without the project. Given the positive or negative change (B) in consumption possibilities, the project now decreases the uncertain range in the state of the economy, from (CL, CH) to (CL + B, C_H – B). Hence, expected utility (or welfare) is higher than without the project. And this is even better the larger the fluctuations are. Suppose that the change is not B but $A + B$, which means that the range of uncertainty is reduced to just (CL + B + A, CH – B – A). Then the expected utility is even higher. Hence, if a project's returns are negatively

correlated with the state of the economy, the more uncertain it is, the higher the project's value and the lower the risk premium in the discount rate.

So what are the practical implications of all this? Consider the case of investments to reduce global warming. Global warming is thought to affect the state of the economy negatively, but it is unclear to what extent this is the case. Suppose we invest today in reducing the emissions of greenhouse gasses. If global warming is not as damaging as we thought it was, these investments are basically wasted money. The economy is booming as global warming is not very damaging, and we would have been even better off when having invested our funds in other projects than greenhouse gas emission reduction. Hence, the future state of the economy is high, and the profits foregone imply that we are worse off than if we would have invested our funds in other projects.

If global warming is more damaging than we thought it was, the future economy is going to be in a poor state. But it would have been in an even worse shape if we would not have invested in reducing GHG emissions today; the projects thus result in a positive payoff, making the world less gloomy than if we had invested our funds in alternative projects.

In short, it may well be defendable to impose a *negative* risk premium on projects preventing global warming, rather than a positive one; the benefits may need to be discounted at a social discount rate which is below the risk–free discount rate.

To summarize:

The more uncertain the future state of the economy, the more society should save and hence the lower the social discount rate.
Given the future state of the economy, if a project's payoff is uncorrelated with the state of the future economy, the larger the project's uncertainty, the higher the required risk premium and the less likely we are to invest in the project.
If the project's payoff is correlated with the state of the economy, the 'risk premium' should be positive or negative depending on whether the project's results are positively or negatively correlated with the state of the economy.

So, when considering the possibility of putting a risk markup on the social discount rate, it is clear that it is not very straightforward what numbers we should use. Are environmental projects 'normal projects' in the sense that the market price of risk also applies to these projects? And how can we determine whether the benefits of the environmental project are likely to be pro– or rather anti–cyclical?

Clearly, these are difficult questions to answer. An alternative for risk–adjusted discount rates is scenario analysis, in which possible outcomes are considered first, and are then discounted at the risk–free social discount rate. Remember that adding a risk premium to the discount rate is essentially a short–cut to directly valuing the welfare consequences of positive and negative shocks that may occur in the future. Hence, capturing these in scenario analyses is the same, but it leaves more room for government judgments, should similar outcomes occur.

But there is also a second reason why capturing risk via the discount rate is not the preferred approach. Basically, when adding a risk premium to the discount rate, it is assumed that the agent cannot respond to the outcomes obtained; her hands are tied, and whatever good or bad happens, she has to accept the events as they come. But this is not always true; if bad outcomes materialize (or if there is new information about the probability that outcomes will

be bad), agents can take measures trying to mitigate the negative consequences. This will be explained in the next subsection.

4.6 The value of new information

The insight that agents can react to new information arising is a crucial one. If good and bad developments are viewed as something you have to accept, more risk always translates into lower expected welfare –because of risk aversion. And hence the expected benefits of an environmental project are deemed to be smaller, the larger its risk. But higher levels of risk may actually increase the value of environmental projects (and other projects alike) IF one can act in response to the new developments.

A (quite lengthy) example can clarify this argument. Consider a country that is endowed with 1000 hectares of rainforest, which provides habitat to a diversity of species. These 1000 hectares can be conserved as rainforest, thus protecting the genetic information stored in all the species that live in this area. But the country's government can also decide to allocate the land to agriculture, thus causing all species (some of which may be unique –or endemic– to the region) to go extinct.

Suppose that the two options are valued, and that the analysis shows that conserving all the species yields an annual flow of services with a value of 15,000 euros with 100% certainty, and that the annual agricultural yields are 16,000 euros, also with 100% certainty. Suppose that there are no other considerations than these values. The government would decide to cut the forest and allow people to start undertaking agriculture. The annual net benefits of agriculture are higher than those of forest conservation and if the two flows are discounted at the same rate, agriculture is the preferred economic activity. The forest should be cut today.

Now suppose that the annual benefits of forest conservation are uncertain; they may be 20,000 euros with 50% probability (for example because it turns out that some of the genetic information stored in a species can help produce a drug against cancer), or only 10,000 euros with 50% probability. Note that the expected value of the forest is still 15,000 euros, which is still 1,000 euros less than what agriculture (is expected to) yield. By all measures the risk of forest conservation has increased while agriculture is still risk–free. Thus if one augments the 'risk–free discount rate' with a premium to accommodate risk, the flow of forest conservation services would be discounted at a higher rate than the flow of agricultural revenues. If the government decided in the risk–free case that agriculture is the better option, it is even more so with risky returns to forest conservation.

But now suppose that the government is faced today with this 50–50 risk, but that in one year's time it knows whether the cure for cancer is hidden in the 1000 hectares of forest, or not. Suppose the government postpones the decision whether or not to cut the forest for one year. The opportunity costs of postponing are the foregone agricultural yields it could have earned during the year. And if the government receives the information that the cure for cancer is not hidden in its forest, it has gambled and lost: the land should be converted to agriculture, and the foregone yields are a material loss. But if it turns out that the cure for cancer is hidden in the rainforest, the government decides not to deforest and earns 5,000 euros more in every year to come. Risk has increased, but forest conservation may be the preferred outcome, depending on the length of the time horizon, etc. This is the case if the benefits exceed the opportunity costs of foregone agricultural income for the year's waiting period.

To hammer the point home: suppose that in the above 50–50 risk (10,000 vs. 20,000) example the benefits are exactly equal to the opportunity costs of foregone agricultural income for the year's waiting period. Hence, the government is indifferent between cutting today and

doing agriculture, or postponing the decision with one year. Now let's increase risk a little more. Again we use 50–50, but now the benefits of forest conservation are either 30,000, or 0 euros. Again the expected value remains unchanged, but risk increases. Is agriculture the most preferred option (as when capturing more risk by increasing the risk premium in the discount rate), or forest conservation? The opportunity costs of postponing the decision with one year remain unchanged, but if the cure for cancer turns out to be hidden in the forest (which happens with a 50% probability), the government earns 15,000 euros per year more as compared to agriculture. If the benefits are exactly equal to the opportunity costs of foregone agricultural income in case of the 10,000 vs. 20,000 case, the government strictly prefers postponing the decision by one year in the 0 vs. 30,000 case. The opportunity costs of agriculture remain unchanged, while the benefits in case of 'good news' are higher.

So, we find that it is not difficult to construct an example where the benefits of conservation go up with higher risk. If one would prefer to take the short cut of changing the discount rate when valuing *expected* returns, it should be decreased rather than increased. What is essential to this analysis are two things:

The decision maker should be able to react upon the new information (by changing his/her behavior/strategy).
The new information should change the preferred action (e.g. the value of forest conservation does not increase if risk increases from 15,000 with 100% certainty to a case of a 50% chance of 15,500 and 50% of 14,500 euros).

In view of this example, we think that the proper way to treat risk in environmental SCBAs is to develop scenarios capturing the most important possible outcomes of the project under consideration, identify what the government's best response would be for the various possible outcomes envisaged, calculate the proper expected value in each of the future periods and then discount the whole sum at the *risk–free* social discount rate.

4.7 Putting numbers to the core equation (4.5)

On the basis of the above, the key elements remaining in the social discount rate are the probability that Earth will be hit by a meteorite (as arguably there is no best response possible to that event occurring, if mankind is indeed wiped out by the event), and (society's valuation of) the rate of growth of the economy. In short, the social discount rate is equal to

$$rs = \rho s + \mu s g s, \qquad (4.7)$$

analogous to (4.1). Comparing (4.1) and (4.7), the consumers' pure rate of time preference ρp is the utility discount rate and reflects impatience to consume as well as the probability that the individual dies. Estimates of consumers' pure rate of time preference are usually around 1.5% (see for example Stern et al., 2006). However, since this rate is linked to the individuals' probability of death and impatience, a transfer of this number to society is not correct, as was discussed above. Taking a number close to zero for the societal *pure* time preference for utility is better founded, because in an intergenerational context pure time preference for utility does not coincide with the usual sense of impatience. That is because events happening beyond the lifetime of the current generation are irrelevant to the actual experiences of that generation (Rothenberg, 1999). From a normative point of view (for example, from the standard utilitarian point of view) it could be argued that the pure time preference for utility

should be zero in an intergenerational context, since all generations count equally. Also the probability of extinction for a society as a whole is lower than the individuals' probability of death. The *Stern review*, for example, takes a value of 0.1% for the pure rate of time preference (Stern et al., 2006). The review complies with the standard utilitarian view that all people count equally, even if they live in different time periods. Therefore, no account is taken of *generational impatience* in the social pure rate of time preference, or in other words, the social time preference for utility is set at 0. The 0.1% thus simply reflects the probability of extinction.

The second part of the discount rate, μsgs, is related to the growth in consumption. The faster consumption is expected to grow over time, the higher the consumption discount rate. This provides a generally accepted rationale for a positive discount rate. Note, however, that a negative growth in consumption gs would imply a low or even negative discount rate! The connection between consumption and utility is given by the elasticity of marginal utility of consumption μs. This means that if consumption increases by 1%, marginal utility will fall by μs%. So, for $\mu s > 0$ we have the usual case of diminishing marginal utility of consumption. For individuals this can reflect two things. If the individual gets richer in the future, the utility attached to an increase in income is likely to be lower. Furthermore, the parameter μ can reflect the individual's aversion to fluctuations in income level, in case of uncertainty. For individuals the estimate of this number is usually above 1, in the range 1.2 to 1.6 (Evans, 2005), but again the question can be asked which value society should take.

In general one can say that the parameters ρ_s and μs are taste or even ethical parameters, whereas g is a technical parameter that can be estimated to the best of our ability. The parameter ρ_s was discussed earlier and is related to the chance of society becoming extinct, but it can also be used to discount the utility of future generations and has therefore an ethical component. The parameter μs can be seen as a value judgment as well. It expresses how society wants to cope with rich and less rich generations and with redistribution between rich and poor within a generation and how society wants to handle uncertainty. The consequences of these choices are huge. The *Stern Review* takes $\rho_s = 0.001$, $\mu s = 1$ and $gs = 0.013$ (but see Nordhaus 2007 and Weitzman 2007 for criticism on the numbers used, see also below). Together, these numbers yield a social consumption discount rate r_s of 0.014 (or 1.4%, Stern et al., 2006).

If we follow the position of the *Stern Review*, we can answer the question whether the government should raise taxes to fund an environmental project that yields a 1% rate of return. No, we should not; only those projects that yield a rate of return of 1.4% or higher, should be implemented. Note the underlying reason. All future generations are essentially equally important as the current one (ρ_s is very close to zero), but because future generations will be better off than the current one (because of economic growth), it suffices to just implement those projects that yield an internal rate of return of 1.4% or better.

This explains the underlying rationale, but of course estimates of the relevant coefficients may differ. The UK Green book, for example, uses an (initial) social consumption discount rate of 3.5% ($r_s = 0.035$) based on $\rho_s = 0.015$, $\mu s = 1$ and $gs = 0.02$ (H.M. Treasury, 2003). Others may, however, very well argue that one should take $\rho_s = 0.02$, $\mu s = 2$ and $gs = 0.02$ which yields a social consumption discount rate of 6% ($r_s = 0.06$). The present discounted value of a given loss due to global warming a century from now at the last discount rate is only 1/8th of the present discounted value of the same loss at the discount rate in the UK Green book, or even only 1/100th of the present discounted value in the *Stern Review*.

4.8 One discount rate, or several?

As is clear from the previous section, different values for the social discount rate can be well defended. Suppose that the three values from the previous section (i.e. 1.4%, 3.5% and 6%) are considered to be equally likely to constitute the correct social discount rate. That is, there is a one third probability for each of these values that it is the correct discount rate. What discount rate should the government use now? Weitzman (1998) shows that when one considers multiple possible discount rates with a given probability each, one can calculate a certainty equivalent discount rate for each point in time. This is the discount rate the government should use. This rate proves to be declining over time! The reason is that the weight of higher discount rates reduces over time because their respective discount factors fall faster. In table 4.1 the results of the calculations are presented, assuming probabilities of one third for discount rates of 1.4%, 3.5% and 6%. The certainty–equivalent discount rate drops from 3.45% for a time horizon of ten years to 1.95% for a longer time horizon of 200 years. Eventually it will approach the lower boundary of 1.4%.

Table 4.1: Certainty–equivalent discount rates.

	Discount factors in period t				
Interest rate	10	50	100	200	500
1.4%	0.87	0.50	0.25	0.06	0.00
3.5%	0.71	0.18	0.03	0.00	0.00
6%	0.56	0.05	0.00	0.00	0.00
Certainty–equivalent discount factor	0.71	0.24	0.09	0.02	0.00
Certainty–equivalent discount rate	3.45%	2.86%	2.39%	1.95%	1.62%

So, following this logic, the implication of uncertainty about the correct social discount rate is that the discount rate that is used in practice should be declining. In the recent literature the debate has focused on the question whether a declining discount rate is indeed a proper assumption, or not. A declining social discount rate would further reduce the relative unimportance of future costs and benefits and is therefore seen as an important step in reaching more acceptable SCBAs. Indeed, uncertainty about the appropriate value of the discount rate is just one reason why the social discount rate should be declining over time. Other rationales for a declining social discount rate are, for example, ideas from Gollier (2002) and Li and Löfgren (2000). Gollier starts from uncertainty on the growth of consumption and shows that this can also explain a declining discount rate. Li and Löfgren start from different opinions on the pure rate of time preference in society and again find a declining discount rate as a result of that.

Consensus is growing on a declining discount rate and the UK H.M. Treasury (see H.M. Treasury, 2003) has decided to apply this in practice and uses the following discount rates: see table 4.2. [14]

Table 4.2: Discount rates used by the UK government.

Period of years	0–30	31–75	76–125	126–200	201–300	301+
Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

Source: The Green Book.

One theoretical issue remains. It is somewhat strange that if the certainty equivalent discount rate is recalculated at some point in time, it would jump up and then decline again, so that it will not stay on the same path as was initially calculated. This phenomenon is called 'time–inconsistency'. As a consequence, preferences are not stable over time but may change. This shows up in behavioral reactions such as procrastination or present–biased preferences. A government that is unaware of its unstable preferences, may decide to postpone the start of environmental action to next period (say 'tomorrow') because this seems optimal after having correctly discounted the relevant costs and benefits. However, when the next period arrives, the government may again decide to start 'tomorrow', and so on. A government that is aware of its self–control problem may want to commit itself to stick to the originally designed policy plan. In principle commitment is a possible remedy to prevent time–inconsistent behavior. However, it may be very difficult to find a good commitment device for a government.

4.9 Actual project implementation and valuing individual projects

As was stated explicitly in section 4.2, the analysis above applies to discounting flows of consumption of a composite consumption good, and hence does not explicitly allow for an analysis of how changes in preferences or relative prices affect the rate at which particular goods or services are to be discounted. This is relevant because economic growth (as embodied by parameter g_s in equation 4.5) affects the relative valuation of various goods. Indeed, environmental goods are often so–called luxury goods, the demand for which tends to increase more than proportionally with income. So if people's valuation of environmental goods grows over time, how should we take that into account when constructing our discount rate?

Suppose that for a specific project there are two flows that need to be taken into consideration; the costs of maintaining an environmental good (with per–period costs equal to C), and the benefits it provides. Suppose that the valuation of these benefits increase with a% per year (starting at a level $B0$,) and that the appropriate discount rate (as derived along the lines discussed above) is equal to r%. Then the net present value of this investment project equals:

[14] Note that this does not mean that one should use a constant discount rate throughout the planning period for projects lasting 31 to 75 years (or longer). Instead, it implies that for a project lasting 75 years, the benefits and costs should be discounted back to 50 years using a discount rate of 2.5%, then discounted back to 10 years using a discount rate of 3.0%, and then discounted back to today at 3.5%.

$$Z = [B_0 - C] + \left[\frac{B_0(1+a)}{1+r} - \frac{C}{1+r}\right] + \left[\frac{B_0(1+a)^2}{(1+r)^2} - \frac{C}{(1+r)^2}\right] + \ldots \qquad (4.8)$$

which is roughly equal to *B0/(r–a) – C/r* if the time horizon is infinitely long and if periods are sufficiently short. So here it is clear what the consequences are of 'relative price changes', nature increasing in value whereas other consumption goods do not: the financial flow is discounted at rate *r* but the environmental benefits at rate *r–a*. However, the same criticism as for the risk premium applies here. If the scenarios capture the relative price changes, then there is no need to adjust the discount rate.

Of course this is a very rough description of the underlying method; a more advanced approach is presented by Sterner and Persson (2007). They also assume that environmental goods and services get scarcer and that the relative price with respect to other sectors is not constant. Interestingly enough, when they adjust the standard discount rate (in their case: 3%), taking into account these relative price changes, they find an effective discount rate for environmental goods that is very close to Stern's discount rate of 1.4%.

4.10 Conclusion

The discussion on the proper discount rate is an old one. This debate is still not settled and will probably not be settled in the near future. Nevertheless, the literature has produced a large number of interesting insights that can be of use to policy and decision–makers. In this section we have tried to argue that just using the market interest rate or the consumer discount rate or the firm's internal rate of return as the discount rate for SCBAs is too simple and not correct. Having said this, however, there is still ample room for debate, especially because part of the issue is a not a technical economic one but an ethical one. The state–of–the–art in economics can help, however, to shape the proper framework in which this discussion can take place.

5. The role(s) of SCBA in environmental decision making processes

5.1 Introduction

Chapters 2–4 focused on SCBA as an important decision support instrument. It was explained how to deal with valuation, discounting and risk, when SCBAs are used to support environmental decision making. This chapter concentrates on the question how SCBAs may be positioned in environmental policy processes:

> *What role(s) can an SCBA play in the decision–making process? And at what point in time? How can policy–makers learn from the analysis contained in an SCBA (e.g. policy modification, phasing)?*

A number of sub–questions, formulated by the Ministry of VROM, will be discussed in the following sections (these questions are put in italics). Several questions are also addressed by the recent CE study 'Leidraad MKBA in het milieubeleid'[15], also commissioned by the Ministry of VROM.

SCBAs are instrumental to policy–making processes. They aim at structuring information and making this information as comparable as possible, within certain limits (such as the budget available for making a detailed SCBA). SCBA's should not be made and interpreted in isolation, but are part of a (political) policy–making process in which the different actors can have different goals and different values. They may have a different interest in certain outcomes and different actors can have a different opinion about the question if SCBAs are indeed a proper instrument and have an added value to policy-making or not.

5.2 Typical characteristics of environmental problems

Three dimensions make many environmental problems different from many other policy issues: the influence of a wide 'stakeholder landscape', the environment as a public good, and the long term impact of environmental measures.

In the first place, environmental politics is a field where, in most cases, a large number of actors have vested interests, different values and goals and demand to be involved in one way or another. Because of their different perspectives and political or social-cultural backgrounds, stakeholders may have very different views on what the problem is, whose problem it is, how to (e)valuate the problem and how it should be solved,. Dialogue and debate are value-laden. It is a policy field that is not only usually multi–actor, but also multi–sector (relations with other policy fields) and multi–level (involvement of different layers of government, including the EU). This makes the governance of environmental politics complex. It requires good process management and a well–picked governance approach. Apart from routine issues and clear government tasks, most complex environmental problems require some form of stakeholder participation (EEAC, 2003)[16], and therefore some form of the 'new

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[15] CE (2007): Leidraad MKBA in het milieubeleid.

[16] EEAC (2003): European Governance for the Environment.

modes of governance' (Héritier, 2002)[17] that have emerged, like network governance (cooperation based on trust) and market governance (cooperation based on competition and price), and the combination of both, in for example the EU's Open Method of Coordination (OMC). According to Jänecke[18] a "culture of dialogue and consensus" is an important condition for successful environmental policy. The conclusion of the above is that environmental policy–making is often unpredictable and non–linear. External 'disturbances' of the process may turn around the policy–making phases that were so carefully planned. Good risk management is necessary, and if only for this reason, transparency and accountability should be on a high level. This of course also applies to the choice and the position of ex ante assessment methods (such as impact assessment with or without CBA) in environmental decision–making processes.

The second characteristic of environmental policies is that they aim at protecting public goods (air, water, soil, nature). Because soils are usually also privately owned, they are not only public goods, and soil protection was therefore the last environmental sector for which policies were developed. Public goods are not market goods.[19] Dealing with public goods requires ethical and political discussion: values are involved.

The third dimension is the long term dimension. Complex problems like climate change and future energy security in an uncertain world remind us that in environmental policy very long term decisions have to be made. However, governments tend to have problems with taking long term decisions. Firstly, because they conflict with the usual 4–5 years political life cycle of a government (the results are not harvested in the ruling period). Secondly, the longer the impact of a decision, the more uncertainty is involved. Furthermore, there is a lack of decision support systems for long term decisions, or in the existing instruments such as SCBAs high discount rates are used so that resulting alternatives make many long term investment look unwise. At the same time, there is a growing sense that we need long term investments and other measures to achieve a more sustainable future of our societies. This is supported by the development of specific methods for assessment of possible futures, such as scenario methods and horizon scanning (the latter for example in the UK and the Netherlands). Such methods can be combined with the use of SCBA, for example by developing SCBAs for the main scenarios. In the context pictured above, the question of the governance of long term decisions becomes urgent. This makes the question, under which conditions governments may take wise decisions with a long term perspective, urgent.[20] Sub–questions include:

- How to find a rationale for political leaders which makes it more attractive to them to take the risky road of long term decision making? How does this relate to the rationality of looking at the electorate (with at the same time relates to the communication issue, see above)?

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[17] Héritier, A. (2002): New Modes of Governance in Europe: policy making without legislating?

[18] Jänecke (2005: 137): Trend–setters in environmental policy: the character and role of pioneer countries.

[19] However, (pseudo)markets can sometimes be created for public goods, as the Emission Trade mechanism of the EU shows.

[20] In 2008 RMNO, in cooperation with a number of other European advisory councils (EEAC), will present a statement on this question.

- How is the relation between the time horizons of voters and of politicians? Do politicians who want to take long term decisions, require that these decisions are broadly supported by society? And how can the latter be achieved better?
- What are the perspectives for long term decision–making in different types of (mixed) Western democracies? How to deal with the emerging 'deliberative democracy' in relation to the classical 'Rechtsstaat' (continental) and 'public service' (Anglo–Saxon countries) types of democracy?
- How may societal actors influence the willingness of governments to invest in long term solutions?
- How may governments use (sustainable development) advisory councils with civil society and business representatives in order to create more support for long term decisions?
- How is an optimal governance approach for long term decision–making related to national political, administrative and societal cultures?
- What are the latest developments in long term decision support systems, what are the risks and uncertainties linked with different methods, and how to find a situationally optimal instrument mix?

To conclude: there are still many questions unanswered with regard to how environmental policy decisions with a long term effect may be developed in an optimal way.

5.3 Hard facts and soft knowledge? Value–laden knowledge in environmental policy making

Policy making on environmental issues is, as it is the case with other societal issues, usually a relatively fuzzy process in which many actors in the 'policy arena' are involved and influence each other. The production of knowledge to support policy making is also not a neutral process, but is value–laden and influenced by actors in 'knowledge arenas'. Therefore, a strict separation between science ('the world of measuring') and the policy arena ('the world of weighing') is not possible. Knowledge production for environmental policy making should begin with an open debate about the points of departure that form the basis of knowledge production. Such a debate should lead to a decision by the principal (a minister, for example), not by the knowledge producer. These are some of the main conclusions of the study 'Willingly and Knowingly' which the RMNO published in 2000. In this study knowledge is considered as negotiated knowledge. The assumptions are: [21]

- Knowledge is meaningful information;
- What is meaningful depends on one's values;
- Values are often subject of discussion and negotiation.

However, hard facts, symbolized by concrete numbers seem to be extremely attractive for politicians and the media. In this way they (try to) rationalize their decisions, which helps to explain and communicate these decisions easier. In addition, SCBAs rely to a certain extent on the availability of 'hard facts', and if hard facts are scarce as is often the case in dealing

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[21] In 't Veld (ed.)(2000: 127): Willingly and Knowingly.

with complex societal issues, SCBAs help to translate the more 'soft' and 'contested' facts into economic terms which may seem more 'hard', 'rational' and 'objective'.

Building a joint knowledge base

When a decision is made to begin a policy–making process with a certain goal, policy-makers will start collecting facts, figures and information from various sources. Together these will form the preliminary knowledge base. How to do this best depends on the type of policy issue: is it very urgent, or a rather routine issue, then in general there will not be many actors involved in collecting and interpreting the findings. However, for complex and 'unstructured' issues, in which many actors have different interests and information, a process of Joint Fact Finding (JFF) is advisable. One reason is that only all actors together can oversee the complexity of the issue. Another reason is that JFF is an approach that helps resolving disputes over the valuation of the collected knowledge. If this is not done in an early phase of policy making, it will come return as a boomerang in a later phase, as the experience with e.g. the Dutch Betuwelijn railroad has shown.[22]

The main issue in such a process is not whether the produced knowledge is *'true'*, but if it is *useful* for solving the policy problem. Three types of knowledge questions can be differentiated:[23]

- Phenomenal knowledge questions: what is happening? What can we see?
- Causal knowledge questions: why is this happening? Why is it the way it is?
- Actionable knowledge questions: what should be done? What are the possible actions?

Some parties tend to prefer one type of questions. This causes problems when deciding on the 'usefulness' of the gained/negotiated knowledge. NGO's such as environmental pressure groups often focus on the first question type: what is happening? Research institutions tend to prefer the second type of question: why is this happening? Politicians seem to prefer the third question type: what actions have to be taken? Therefore, it appears that in (political) processes of gaining (negotiated) knowledge all types of questions have to be covered. Another reason to cover all types of questions is that parties may come up with new questions at an inconvenient moment, such as just before the final conclusion or decision is made, which can cause delay of the process.

The result of this phase may be a matrix with an overview off all knowledge about the (possible) effects of different policy options. This overview matrix may contain hard facts, but also soft knowledge. Two of the main characteristics linked to SCBA's, namely structuring information and actively striving for 'completeness', already emerge in this phase.

5.4 The choice of the method: 'to SCBA or not to SCBA?'

In Chapter 1, it was stated that the Minister of VROM has decided that weighing costs and benefits will become more important in environmental decision making. If a (full) SCBA is

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[22] In 't Veld (ed.)(2000): Willingly and knowingly.

[23] Eberhard, Kurt (1999), p.15–18.

chosen, it has to be transparent why this method, in a specific case, is more adequate than other methods. VROM has asked:

Should SCBA's be made compulsory in particular instances?

More and more SCBA's seem to be made compulsory (see for example the Impact Assessment that is compulsory inside the European Commission). Should SCBA's be made compulsory in particular instances in the Netherlands too?

Pricing and precaution

Before answering this question, it should be noted that 'putting price tags' on nature or on human lives is not undisputed. However as already argued in Chapter 2, the key to SCBA (or economic valuation techniques) is to determine how many other goods and services humans are willing to maximally sacrifice in order to obtain an environmental benefit (or to prevent an environmental deterioration). In this approach, 'money' is nothing more than the measure of consumption possibilities. And, as argued in chapter 3, techniques are available to induce citizens to reveal their 'true' value of public goods, suppressing the incentives for free-riding which may be present in actual behaviour. Not putting a price-tag means, in this way of reasoning, that 'the value of nature' of a human being is infinite and hence beyond debate. One might argue that such a position would be reflected by humans being willing to sacrifice all they have (including their own lives?) to prevent environmental degradation.

I real life such sacrifices are rare: most principles are, under certain conditions negotiable. This also applies to environmental principles like the polluter pays principle and the precautionary principle. Both principles are included in the Treaty on the European Union (Maastricht, 1992).

The question is, what are these conditions?

If the precautionary principle applies for a decision with possible negative effects on the environment, this means that the actor who takes the initiative for the decision has to prove that there are no negative effects. The same applies to the introduction of new medicines. However, even in the latter case trade-offs have to be made between a certain death and uncertainty about effects of a new medicine, for example.

It has been argued that CBA and the precautionary principle are based on competing paradigms.[24] It is therefore important to define procedures and norms to make the principle more practicable, and to define the relationship between both concepts in a certain case. A general procedure could be to let the precautionary principle prevail when the environmental risks of doing something (or nothing) seem to be high, but at the same time very uncertain.

As long as the precautionary principle applies unconditionally, the values of the environment, nature, people, are infinite. This makes it impossible to include them in a CBA. It is an incentive for the initiator of a project to do his utmost best to investigate possible environmental damage.

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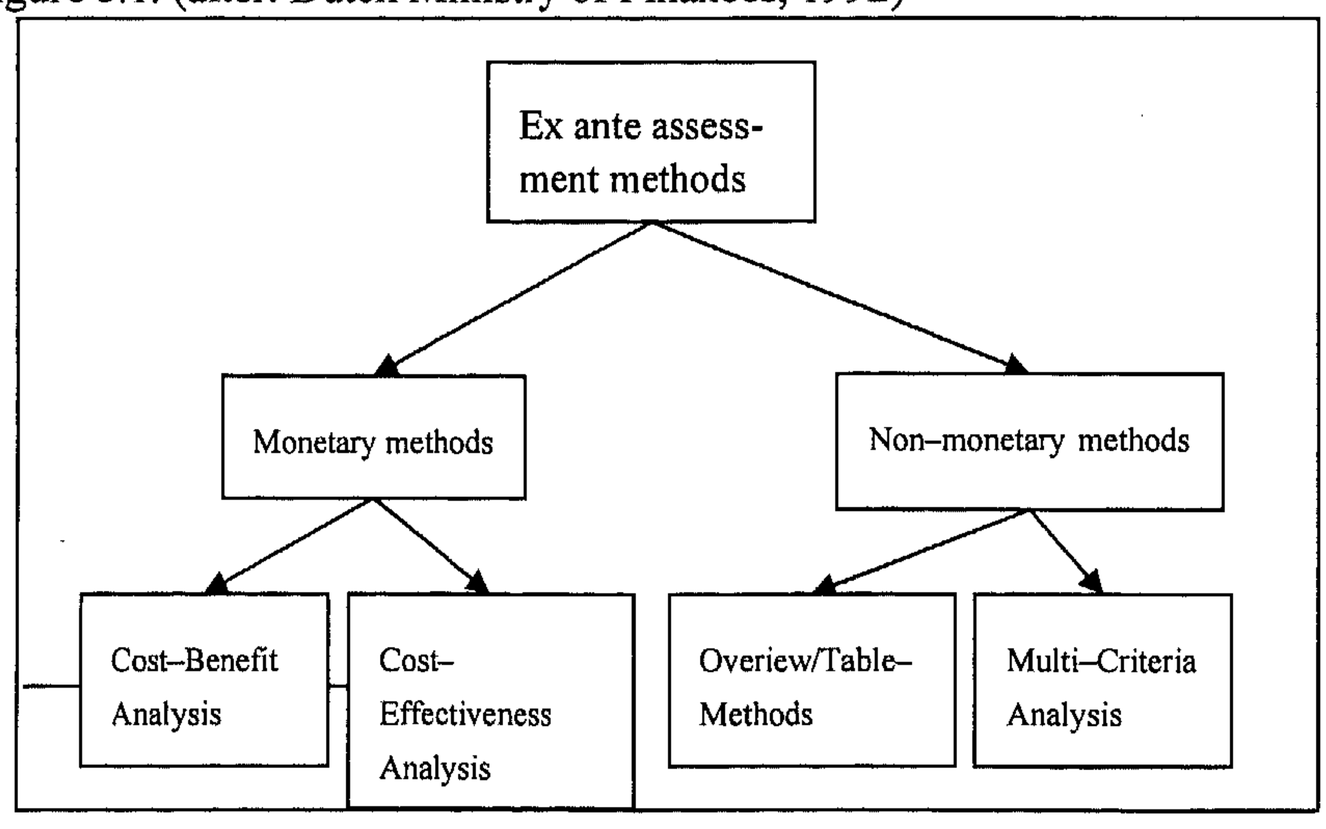
[24] Kysar (2006): It might have been: Risk, precaution, and opportunity costs.

CBA and other methods

Obviously economic valuation techniques are not the only available decision support technique. Multi-criteria analysis is another. MCA and SCBA are identical in that they both try to determine what the (physical) consequences of a specific project are. Consider protecting the rain forest. In the short run we gain biodiversity (or prevent its loss), but we also deny humans a potential source of income (of course, in the long run biodiversity conservation and economic growth can coincide; this is just an example to make trade-offs very transparent). Both techniques determine how much extra biodiversity we gain when implementing forest conservation, and how many human lives do we lose in expectation, etc. They differ in the final step. Whereas MCA leaves it to the decision maker in dialogue/debate with society how to compare a 1% increase in biodiversity to the loss of certain number of human lives, SCBA tries to infer the weights by establishing how citizens make these trade-offs in an economic way.

Apart from the acceptability of monetary figures to capture indifference, another factor that may influence the choice of a method is whether it is preferred to have a calculation model such as SCBA (the crucial phase is the determination of the assumptions, the rest is arithmetic), or more a process model such as MCA (in which the crucial phase is the determination of weights). One problem is that undisputed estimates of environmental damages are very scarce in environmental politics. Similar as with innovation projects, there is usually a large deal of uncertainty about the effectiveness and the risks of complex environmental, long term policy measures. For innovation projects, Rand Corporation therefore advised the Ministry of Economic Affairs *not* to use SCBA's, but rather a mixture of other methods such as MCA.[25] There is no reason why this should not also apply to (long term) environmental policy–making. With long term environmental issues such as climate change, in addition other arguments may apply, such as the precautionary principle, mentioned above. Therefore, many authors plea for a discursive, or at least a participative approach for 'unstructured' problems (e.g. in 't Veld et al., 2000; Ott, 2004, Vatn, 2005)(see also 5.3.8). One argument for the use of discursive methods would be that (individual and social) preferences evolve through learning and dialogue. An overview of available decision-making tools is presented in Figure 5.1.

Figure 5.1. (after: Dutch Ministry of Finances, 1992)



[25] Van Ree (2006): Kan een MKBA worden gebruikt voor de evaluatie van innovatieprogramma's?

The next question is:In which policy areas can an SCBA be effective? In all areas, or is it possible to set priorities?

The answer to the question if SCBA can be an effective method in all policy areas, depends on the context, the phase of the policy-process, the factors and normative assumptions one wants to take into account, the quality of the knowledge base and the question how much consensus there is about the knowledge base and the value-laden assumptions. In principle, in all areas there will be alternatives and impacts that have to be assessed, and structuring the information is welcomed. The appropriateness of SCBA depends on the extent to which it is able to induce citizens to reveal their collective preferences in specific projects (that is, to overcome their inclination to answer strategically). This is challenging, because people's private and collective preferences are usually very different (Vatn, 2005). There are several alternative types of decision support methods that can provide policy information; see Figure 5.1. Therefore, to conduct effective ex ante evaluation of alternatives in a given case, analysts and decision–makers must first choose the type of choice method: a meta–choice.[26] Explicitly and transparently choosing the assessment method does not only produce better usable results, but also prevents unnecessary discussion: Some of the criticism on the use of SCBA's is not pointed at the method as such, but at its use in a situation in which another method would be more adequate.

Vining and Boardman (2006) propose that the meta–choice decision depends on two factors: (1) goal orientation and breadth, and (2) willingness to monetize efficiency impacts. If the answer to the second question is positive, then five types of analyses can be distinguished:[27]

- Integral SCBA
- Business impact analysis
- Partial SCBA
- Extended Cost Effectiveness Analysis.
- Traditional Cost Effectiveness Analysis.

SCBAs and Environmental Impact Reports

How will SCBAs relate to existing support tools such as the MER (Environmental Impact Report)? What is the relationship with existing legal analyses such as the business impact analysis?

Environment Impact Assessment (EIA) was introduced in the 1970s as a 'partial cost–benefit analysis'.[28] The use of alternatives, a zero alternative and of effects was copied from

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[26] Vining and Boardman (2006): Metachoice in policy analysis. Journal of Comparative Policy Analysis: Research and Practice, Volume 8, Issue 1 March 2006 , pages 77 – 87.

[27] CE (2007: 28): Leidraad MKBA in het milieubeleid.

[28] Spaink, E. (1978), Verplichte milieu–effectrapportering, waarom en hoe, in: *ESB*, nr. 3175, pp. 1032–1036. See also CE (2007: 29).

CBAs. Both methods have since then developed rather separately. This has led to differences that may make it challenging to attune them:

- An SCBA investigates all effects of possible solutions for a problem, while an Environmental Impact Report concentrates on the effects on nature and the environment; SCBA has a wider scope.
- An SCBA usually results in a monetary valuation of the physical effects. In an EIR the effects are, if they are valuated and compared, weighed with the help of a multi–criteria analysis.

Another difference is (see also 3.1.3) that both methods use a different definition of the zero alternative. The zero alternative in an EIR is based on 'doing nothing' (else than current policy), whereas in an SCBA certain 'plausible' (important question: for whom?) policy measures can be included in the zero alternative.

In practice, the spatial scale is often different: in an EIR the scale is usually regional, in an SCBA national. However, this is not a fundamental difference: if required, SCBAs can be made on local, regional, national, or transnational scales.

If an EIR is legally required, the use of an SCBA can improve the knowledge base, because it explicitly tries to infer weights from citizens by eliciting their (collective) preferences. If an EIR is not required, the EIR requirement of participation can be embedded in an SCBA process.

About business impact analysis, CE states that in practice this is seldom useful in environmental policy making, because it focuses on the direct financial impact for the managing organisation of an investment (such as infrastructure).

Combining SCBA, MCA and deliberation

Relatively recently, participative forms of SCBA have been developed. This has the advantage that the policy process in which meanwhile usually stakeholders are involved, is not separated from the SCBA process.[29] As stated several times above, the key to SCBA is to determine how many goods and services citizens are willing to give up to obtain an environmental benefit. Obviously, this is quite cumbersome in some instances, and it is also not always very easy to induce respondents (in a CVM) to state their collective preferences. To that extent, SCBA may be an input to MCA. SCBA provides weights where ever it can based on citizens' preferences, but then the decision maker is asked to determine the weights between the SCBA outcome and all other project characteristics in an MCA framework. Combining SCBA, MCA and deliberation may therefore have a greater potential. But of course SCBAs are very expensive to implement, and hence expediency/opportunity considerations may induce the decision maker to rely more on MCA and have smaller input from SCBA. A recent example of an interactive SCBA on the regional (the Dutch Frisian Lakes Area) implementation of the European Water Framework Directive, concludes that knowledge of local stakeholders was brought in, without which area-specific aspects would remain underrepresented. In addition, the findings of the SCBA were more readily recognised by stakeholders

[29] See e.g. Klaassen, H.L. (1995), Besluitvorming in afhankelijkheid, een onderzoek naar de rol van de procesarchitect bij overheidsprojecten. Dissertation. See also: Klaassen, Henk L. and Frans K.M. van Nispen (1995), Policy analysis in the Netherlands.

because they were involved in the process. The researchers conclude that this may help accelerate the decision making process.[30]

It seems worthwhile to investigate this further.

5.5 Normative assumptions

A question that can influence the choice of a method(ological mixture) is: Are there normative assumptions used in the method that should be decided in the political, rather than in a scientific/technical arena?

> *Methods of evaluating the environment in monetary terms may be influenced by ethical and moral value judgements. Value judgements may also mean that in particular instances the appraisal of environmental effects in monetary terms may be rejected. It is important to maintain an open attitude here. It must be made clear what social and political assumptions correspond with the choices in the methodology of the cost–benefit analysis, and how. The complexity of the policy issue and the reliability of the appraisal methods used in part determine the role which the SCBA can play in policy formulation.*
>
> *How should the at times broad spread of plausible estimates of the market value of both the costs and the benefits be handled?*

A central issue should be the relative influence of an assumption on the outcome of the assessment. With MCA's this is the choice of the weights per factor. With SCBAs a sensitivity analysis may helpt to take the decision.

As far as SCBA's are concerned, there are three main types of assumptions:

The first type of assumption with a potential high impact on the results of the assessment are assumptions on people's (future) behavior. As is explained in Chapter 3, economists try more and more to incorporate evidence from behavioral sciences in their models. To stay on the safe side – and we have already argued that complex environmental policy–making can be a risky business for politicians – it is advisable to have an interdisciplinary team elaborating the specific assumptions in a given case, and have their conclusions agreed by the (political) responsible(s). If we agree that economic models work with evidence and/or assumptions derived from other (social and natural) sciences, and that economy is a so–called aspect science[31] with scarcity as most important aspect, the conclusion must be that the preparation of an SCBA should be interdisciplinary work. However, it is questionable if this is enough to assess peoples' future preferences in a world in which we do not know which resources will be scare and which other constraints will co–determine the future preferences of people.

Secondly, there are assumptions of the costs and benefits of which the valuation is disputed. Again, not publishing these assumptions is (or should) not be an option for politicians who do not want to get in trouble later. There are many examples of large projects in the

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[30] Reinhard et al. (2007: 10): Benefits of the Water Framework Directive for the Frisian Lake area; an interactive CBA exercise.

[31] Marshall (1920): Principles of Economics.

Netherlands in which the dispute (in the political arena and the media) continued long after the decision was made (Betuwelijn, 5th landing lane of Schiphol Airport). Environmental policy–making has a long history of underestimating the costs of non–intervention, as the study 'Late lessons from early warnings' of the European Environment Agency has shown.[32] Especially in environmental policy making, with its high complexity and long-term impacts which are often difficult to predict, and continuing debates on the (intrinsical and functional) values of nature and the environment, monetisation of costs and benefits sometimes does not lead to (politically) satisfactory results. For such cases the Office for Information and Regulatory Policy (OIRA) of the US government advises to include in the SCBA process a sensitivity analysis.[33]

The third important assumption regards the choice of a discount rate. In Chapter 4 we have concluded that a differentiated discount rate makes SCBAs more acceptable and more realistic. There are however issues that should not be discounted. In a recent policy letter the Dutch Finance Minister decides that (1) for all – national – CBAs a risk–free discount rate of 2 ½ % has to be used (lower than the 4% of 1995, which is still used in the European Commission), and (2) that for investments aimed at problems which are fundamentally irreversible, such as long term issues like climate change, even lower discount rates should be possible, or no discounting at all). [34] The discount rate is also an ethical issue. The growing importance of 'islamic banking' (which forbids interest and discounts with 0%) brings into memory that the Catholic church only in 1882 abolished the ban on interests.

These issues should be dealt with by politicians. In case many stakeholders with conflicting interests are involved, it may be advisable to involve these stakeholders in the discussion on the assumptions (i.e. a deliberative/participative approach).[35]

The next question is:

> *To what extent should the uncertainties surrounding the outcomes of (complex) SCBA's, as well as the influence of value assumptions on the outcomes, influence the position of SCBA's in decision–making?*

This has now been answered: assumptions and uncertainties influencing the outcome of a SCBA have to be discussed and agreed in the political arena. This involves several extra steps in the decision–making process, with in most cases an interactive component. Rand Europe formulated uncertainties for innovation projects that also apply to complex environmental issues:[36]

- SCBA's are usually not transparent and are difficult to understand for non–economists;

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[32] EEA (2000*): Late lessons from early warnings: The precautionary principle 1896–2000.

[33] Source: OIRA (Office of Information and Regulatory Policy) Circular A-4, 17 September 2003: Regulatory Analysis. http://www.whitehouse.gov/OMB/circulars/a004/a-4.pdf [accessed on 4.3.2008]

[34] Minister of Finance (March 2007): Valuation of risks in public investment projects.

[35] Ott (2004): Reflections on discounting: Some philosophical remakrs.

[36] Van Rhee (2006: 6–8): Kan een MKBA worden gebruikt voor de beoordeling van innovatieprogramma's?

- There are usually few data on the effects of measures;
- The long period between investment/decision and impacts makes an ex post evaluation only possible after a long time, and is even then very difficult.

5.6 The EU dimension

The Ministry has asked two questions regarding the European dimension of the use of SCBAs:

> *How will SCBA's relate to European Commission's Integrated Impact Assessments?*
>
> *How can VROM or the Netherlands apply the SCBA instrument for European decision–making (influencing European SCBA's and substantiating the Dutch viewpoint)?*

During the development of the EU Integrated Impact Assessment there have been similar problems and conflicts about different methods, as discussed in this paper. As a result Guidelines were made, which recommend to use a variety of methods. However, CBA often prevails, even if the appropriateness is questionable.

For EU Member States, there is no need to follow the EU internal approach. It is a national discretion to develop the best approaches in the national context.

An evaluation in 2006 of the European Commission's Impact Assessment praxis [37] shows shortcomings that also should be kept in mind when dealing with assessments in the Netherlands. The most significant problems include:

- "Asymmetries: Socio–economic impacts of environmental policies are typically subject to more detailed scrutiny than the environmental effects of sectoral policies. In some cases, even when environmental concerns have been identified, they are subsequently neglected. In the assessment process, NGOs and experts from the environmental sector have not been as deeply involved (formally or informally) as business partners.
- Restricted framing: The scoping and framing of assessments (a particularly crucial phase) is driven by the lead departments, sometimes neglecting the concerns of other sectors and alternative policy options.
- Short–termism and the domination of numbers: Short–term priorities take precedence over longer–term perspectives, and 'hard' forms of analysis, such as cost–benefit analysis and monetisation, prevail over qualitative approaches. This is especially problematic in relation to environmental and other non–market considerations.
- Inadequate quality assurance: There is insufficient 'separation of powers' between the lead DG and the assessing unit, and arrangements for independent review are not well

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[37] EEAC Working Group Governance (2006): Impact Assessment of European Commission Policies: Achievements And Prospect. EEAC: Brussels (endorsed by RMNO).

developed. Shortcomings in quality assurance are exacerbated by a lack of transparency in the assessment process.

- Insufficient capacity: Sound and high quality assessment, especially of complex and far–reaching proposals, is demanding of time, resources and skills; these are not always adequate. Although training for Impact Assessment is provided within the Commission, there remain
- Missed opportunities for learning: The considerable potential for deliberation, social learning and innovation that might be offered by a more open and pluralistic assessment process is not exploited. Rather, assessment is too often used as ex post legitimation of policies and decisions."

It is advised to use these 6 points of critique to asses the quality of European (environmental) decisions which affect the Netherlands, and also the other way around: to influence the way EU policy preparation is determined by the application of the EU IA methods. Since the Dutch government, has decided that for long term decisions a lower discount rate will be used (2½ %, risk free), and if they follow our advice to, like the British government already has done, uses a flexible discount rate depending on the time horizon of the measures, then it seems logical that the Minister of VROM takes steps to ensure that this 'logic of appropriateness' also is taken up by the European Commission.

5.7 Presenting the decision and the underlying data (incl. the assessment reports)

How should the SCBA research be presented (to avoid any misinterpretation)? Should a distinction be made between simple figure–based SCBA's (data book containing only figures) and very extensive analyses (month–long projects by consultancy bureaus)?

How is a SCBA report presented? Sometimes the report is published and the conclusion (usually a cost–benefit ratio for different options) tends to dominate the public and political debate – and in the end also the final decision – whereas it is quite possible that the final policy decision was planned to be based on other considerations too.

However, hard facts, symbolized by concrete numbers seem to be extremely attractive for politicians and the media. The media tend to select 'simple' figures, even if the SCBA report itself provides ranges of values, or indicates that not all values have been estimated successfully. Media tend to report without nuance, not unlike the computer 'Deep Thought' that, when it was asked to answer the question of 'the meaning of life, the universe and everything', after seven and a half million years of calculation came up with a simple answer: the number 42.[38] In environmental policy making the answer is seldom '42' or any other concrete number. Whereas in the case of Deep Thought a new computer needed to be developed to find out what this number actually meant, such information is usually readily available in (thorough) SCBAs. The question here is whether indeed the media take the trouble to go back to SCBA to find out what the cost–benefit ratio stated actually means. Simple answers to

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[38] Adams, D. (1979): The Hitchhiker's guide to galaxy. See also Vining and Boardman (2006): Metachoice in policy analysis. Journal of Comparative Policy Analysis: Research and Practice, Volume 8, Issue 1 March 2006 , pages 77 – 87.

complex questions are popular, and if presented without the context, may have a large impact on the political decision making process.

It is advisable to warrant that SCBA reports, be it simple figure–based SCBA's or very extensive analyses, are only presented as part of the decision–making process, with a context, and not isolated. This has to be dealt with in the contract with the organisation/firm that makes the actual SCBA, and in internal procedures inside the Ministry.

A related question is:

> *How can an SCBA be used externally: both in terms of the process as the results of SCBA's (supporting policy decisions, creating support from players, politicians)?*

Both questions require the involvement of communication specialists. Not only should an SCBA process be accompanied by a communication plan, developed and executed by the responsible ministry, but it should also be guaranteed that before, during and after the making of a SCBA report, effective process management used.

5.8 Summarized evaluation concerning the role of SCBAs in a political process

How can an SCBA be used and optimized in a political decision-making process? Is it just an instrument or tool or do we have to see an SCBA as a process of construction itself? The findings of economic analyses do notalways convince politicians. The prime reason for this lack of conviction is probably that politicians feel uncomfortable about the results of such analyses and in particular about SCBAs. This feeling arises from the – in itself correct – notion that SCBAs often contain hidden assumptions which do not rest exclusively on value-neutral technical principles as argued in the paragraphs before. These assumptions are usually not visible at the end of the exercise. This invisibility arouses mistrust.

The construction of an SCBA should therefore take place against the background of a carefully crafted communication and argumentation process between politicians and scientists. This process should focus on:

- Achieving agreement on the characteristics of the starting situation, often referred to as the zero situation;
- Having the politician understand from shortly after the outset the method and results of an SCBA;
- Leaving to the politician the choice of which assumptions carry a political-normative charge.

If the SCBA is constructed in line with an optimal process, the political decision-maker will have at his disposal an objectified – and therefore not objective – instrument to create conviction at the point of actual decision-making on the project. If the decision-maker has been able to make the sequential normative choices himself, he will also be able to explain these in political debates. The structure of the debate will then be influenced by the method applied in the preparations. It is probably also desirable during the implementation of the SCBA to enable the other stakeholders, including the opposition, to have their own normative assumptions evaluated. This will also avoid the chaos just mentioned. The SCBA will therefore not generate an indisputable result, but will contribute to determining the scope of the

political debate. Naturally, parties can agree that the result of an SCBA will play a determining role in the final decision, but this is not essential. An SCBA can also serve exclusively as a support in decision-making, in the sense of forming a reference framework for the discussion on the decision to be taken.

The main alternative method is that all parties involved in the decision-making carry out their own – often implicit – evaluation and netting of the advantages and disadvantages of a proposal, and then on the basis of their own overall assessment, takes a share in the decision-making, for example, by voting within the majority ruling. In this way, the basis for each person's opinion remains in principle implicit and therefore unspoken.

An intermediate form is a variant of a Multi-Criteria Analysis: each criterion forms an aspect of the evaluation from which each decision-maker can benefit. The relative weights of the different criteria are the subject of a separate political decision. In fact, decision-making via Multi-Criteria Analysis presupposes that each individual decision-maker has assented to a method within which he endorses the combined results of two decisions: on the one hand the decision on the relative weights of the different criteria, and on the other hand the decision that the enumeration of the individual scores on the different criteria, given their particular inter-related weights, is binding for the end result. Odf course the politician has to decide in advance whether he – or a trusted colleague whose judgment he can rely on implicitly – is willing to invest time in an SCBA. This time has to be devoted to discussions with analysts on the reasonableness of choices of normative assumptions. In the reporting on the SCBA, these assumptions should appear as explicit choices. Moreover, it also costs money to construct an SCBA.

In similar later instances, these assumptions can be taken as read. The politician should, however, ascertain whether this commonality is in his opinion relevant.

In the choice between MCA and SCBA, the politician will consider whether the improvement in the quality of the reference framework for the debate on decision-making resulting from the SCBA is at least equal to the investment in time required of him for the SCBA. This consideration will probably have the effect that no SCBAs will be made for very small projects, or simply as a set routine. The comparison of the SCBA with other forms of decision-making support which play a role in environmental policy leads to the following conclusions:

- The Environmental Impact Assessment (EIA) as applied by the MER commission is restricted to a particular series of effects, namely those on nature and the environment, while the SCBA considers all effects, and in methodological terms is similar to an MCA;
- The above-mentioned conclusion relating to comparison between these two methods also applies here;
- The Integrated Impact Assessment as used for decision-making in the European Union comprises a whole collection of methods, including the SCBA. In previous European evaluations, the conclusion was also reached that the methods discussed should not be used subsequently as a means of legitimizing a preference or decision, but as a means of creating a reference framework for fuelling a qualitatively rich dialogue for decision- making.

The SCBA should be constructed within the context of the decision-making process. For communication and argumentation, it is in many cases advisable that the zero situation on

which the project is projected is put into a computer model. From a so-called cockpit, the alternative assumptions relating to the project can then be evaluated. This also serves to enhance the transparency of the whole exercise. If alternative assumptions are introduced, the outcomes of the analysis will also be different. Our recommendation is that a degree of differentiation should always be maintained in any eventual publication of the results of the analysis. Summarizing these assumptions into a single index will all too readily have a demagogical effect and will give rise to a simplistic and hostile debate.

The question of when and how SCBAs should be applied for environmental policy can be answered in a general sense as follows:

Firstly, SCBAs can only comment on the allocative effects of a measure, in other words, in an SCBA only the question will be answered of whether a particular project is beneficial for a community as a whole. An SCBA does not necessarily address the question of whether the advantages of a project will also benefit those who have made a sacrifice for the project, and vice versa. The aspects relating to the division of sacrifices and benefits may be disregarded, while in actual political decision-making these naturally play a prominent role. It is possible to give the division aspects a place within the SCBA. This will require a separate effort. If, for instance, a project were to exhibit some variance from the optimal division, then the quantification of the value of the variance could, for example, consist of the costs of the arrangement that is needed to eliminate the variance.

The evaluation of the effects of a project is in principle already complex, because the causality leads to an unending series of effects. Within the method, agreements are made relating to placing a limit on the effects to be considered. There may, of course, be differences of opinion here. For example: European or national borders do not in themselves play a role as a boundary for the effects under consideration in an SCBA. Parties could agree that these borders are relevant although this would seem to be absurd in environmental policy. The evaluation itself comprises many subjective elements. For example, in cases of actual irreparable damage to the environment, opinions on evaluation may vary strongly. Anyone who advocates an absolute ban on projects which lead to this conclusion, is in fact attributing an eternal value to such an effect; this is of course permissible. The more a person attributes an eternal value to a greater number of different elements, the less the opportunity for negotiation. Dilemmas arise if the existing situation also generates effects with a negative eternal value. Applying particular principles such as the precautionary principle will in many instances hamper the development of projects which conflict with the principle. But the principle mentioned does not help to prevent such a dilemma as that just described.

Naturally, it is important that politicians and decision makers understand the way the method is applied, so that the decision-makers are left with an impression of the plausibility of the result. To increase this plausibility of the end result of the SCBA, it is preferable that repeatedly sensitivity analyses are carried out where the assumptions accepted for the analysis are more or less arbitrary or where there is a lack of consensus about the discount rate. In a number of cases it can also be attractive in the event of uncertainty about achievement of the desired effects to indicate at what level of success the cash value of the benefits will exceed those of the costs.

6. Conclusions

The conclusions of this advice can be summarized as follows:

Chapter 2. General context:

- Assessment of all costs and benefits is needed in order to be able to perform a SCBA that goes beyond a cost–effectiveness analysis or a SCBA with unclear proxies for some costs and benefits.

Chapter 3. Valuation:

- For the use of valuation studies in SCBAs, the Contingent Valuation method (CVM) is the only method to measure non–use values. It has the disadvantage that it is quite expensive to implement and suffers from certain biases. These biases can be mitigated (and techniques to do so get better and better) but never fully removed. Furthermore, it is still under debate if the benefits obtained in one region are transferable to other regions.

Chapter 4. Discounting and risk:

- Just using the market interest rate, or the consumer discount rate, or the firm's internal rate of return as the discount rate for SCBAs is too simple and not correct.
- The decision on a discount rate for environmental decisions has an ethical dimension.
- Consensus is growing on a declining discount rate for longer time horizons, like rates used by the UK government since 2003, which vary between 3,5 and 1 %. It is advised that the Dutch government also decides on a declining discount rate for environmental decisions.
- The more uncertain the future state of the economy, the more society should save and hence the lower the discount rate.
- Given the future state of the economy, if a project's payoff is uncorrelated with the state of the future economy, the larger the project's uncertainty, the higher the required risk premium and the less likely we are to invest in the project.
- If the project's payoff is correlated with the state of the economy, the 'risk premium' should be positive or negative depending on whether the project's results are positively or negatively correlated with the state of the economy.
- However, higher risk can also increase the value of environmental projects if the government can act in response to new developments. It may be better to postpone a decision if the opportunity costs of waiting do not exceed the benefits of new information. In this case more risk implies higher benefits of new information and therefore a higher value of the environmental project. This is relevant, for example, for global warming or biodiversity conservation.

Chapter 5. Roles of SCBA in environmental decision making processes

- It should be taken into account that environmental policy making includes dealing with contrasting interests and values of stakeholder, with the fact that the environment is a public good, and with the complexity of making government decisions with a long term perspective. These special features of environmental policy making require forms of joint fact finding.
- Even if the use of SCBA were compulsory – which we do not advise – it is important to make transparent which assessment method is chosen and why.
- The choice of the assumptions that will be used in an SCBA or other method includes assumptions on peoples' behavior in relation to (long term) environmental issues, assumptions on benefits (or costs) of which the valuation is disputed, and the choice of a (declining or not) discount rate. This should be a political decision.
- It should be further investigated how the need to involve civil society and private sector in environmental decision making, can be reflected in some form of participation in SCBA processes.
- Because the (political) assumptions greatly influence the results of an SCBA, other actors than only the one who takes the initiative should have the opportunity to assess the costs and benefits on the basis of their own normative assumptions. This requires a high level of transparency, and a clear separation between the political and the 'technical' process.
- The requirements to develop political 'ownership' of SCBAs, to develop forms of joint fact finding and participation, and the complexity of valuation, make SCBAs expensive. It is therefore advised to restrict the application of SCBA to large problems.
- It is advised that the Dutch government takes steps to convince the European Commission that in its IA method a declining discount rate should be incorporated.
- Every SCBA process should be accompanied by a communication plan, developed and executed by the responsible ministry, in order to prevent and mitigate the effects of untimely or partial publication of results.

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Annex A-2 Background of the project

1.1 Background

The Ministry of Housing, Spatial Planning and the Environment (*VROM*) has requested RMNO to prepare a report addressing a number of fundamental issues concerning the application of social cost-benefit analyses (*MKBA*'s) in environmental policy and their place in political decision-making. The background to this is the Future Environment Agenda (*VROM*, 2006) which requires a clear indication to be given of the costs and benefits of environmental policy with a view to making such policy more objective and 'business-like/professional'.

> *Passages from the Future Environment Agenda:*
>
> *An objective balancing of costs and benefits. In the structure of the policy, it should be made clearer than is currently the case that the government has weighed up the costs and benefits, and that the objectives of environment policy are achieved in a cost-effective way.*
>
> *In order to make decision-making on future choices in environmental policy more transparent, the Cabinet undertakes to ensure that all relevant social pro's and con's (costs and benefits) are clearly presented. As indicated earlier, the costs of 'non-action' will also be made transparent, as well as the longer term benefits and the specific consequences for vulnerable groups.*

In line with the Future Environment Agenda, it is then expected that *VROM/DGM* (Director General for the Environment) will catalogue the costs and benefits so that informed political decisions can be taken. An *MKBA* is an obvious tool to facilitate this.

Two, largely parallel, sub-projects habe been carried out. Sub-project 1 concentrated on a pragmatic and practical approach to *MKBA's* in environmental policy; this project was contracted to a consultancy bureau. Sub-project 2, the RMNO project, studied the more fundamental debate and issues concerning *MKBA*'s and the position of *MKBA*'s in decision-making.

1.2 The research questions

VROM had formulated 3 key questions for the RMNO sub-project:
What are the appraisal criteria for costs and benefits relating to environmental and sustainability policy?
Are there legitimate reasons to allow deviations to the discount rates (including risk premiums) for issues relating to the environment and sustainability?
What role should *MKBA*'s play in decision-making processes relating to environmental and sustainability policy?

These issues have been the subject of considerable discussion in academic circles, but no best practices have yet been formulated. It is, in fact, likely that such best practices may never be developed since the choices which are made in this respect have to reflect social preferences and/or political choices.

Explanation of the key questions

1) What are the appraisal criteria for costs and benefits relating to environmental and sustainability policy?

Two sub-questions were distuinguished:

1 a) Appraisal methods

RMNO is required to consider the different appraisal methods which are currently available. Which methods are appropriate for which types of environmental issues and are adequately developed? Is it possible to standardise the application of the appraisal methods? On what points and for what applications are the appraisal methods scientifically controversial? (N.B. These questions will also be addressed in sub-project 1).

The irreversibility of environmental effects is difficult to assess, particularly if there is uncertainty about the period of time during which such effects will take place. Irreversibility plays a particular role in climate change and biodiversity. The question is how these effects can be included in an *MKBA*.

A further issue which has to be taken into account in *MKBA*'s in environmental policy is the shifting of problems outside the country. If the *MKBA* relates to an issue on a national scale, then the environmental effects on other countries will not be taken into account. An exception to this rule is the situation where the Netherlands has national objectives for these environmental problems, such as emissions of CO2 and NOX. Also, if a new coal-fired power station causes more emissions of CO2 and NOX, these extra emissions will have to be compensated elsewhere in order to ensure the required objectives are achieved. This is included in the costs of the new coal-fired power station. Another specific example is the CO2 emissions from air travel. These emissions are not assessed in *MKBA*'s, because the airline sector is not included in the Kyoto protocol. This leads to a situation where the extra CO2 emissions generated by the expansion of Schiphol are not included in an *MKBA* on the expansion of the airport. This ignores the very definite negative social effects of CO2 emissions. *MKBA*'s in environmental policy will have to find a way of specifying these costs. Of course, it is up to the political organization whether or not these costs are actually taken into account.

RMNO has also been asked to pay specific attention to the spread in the estimates of both the costs and the benefits of the many research projects available at home and abroad, as well as to the question of the extent to which the spread can be attributed to particular methodologies and assumptions. In addition, the question will be posed of how a large spread in the estimates of costs and benefits can be handled in the presentation of the results and in decision-making.

1 b) The value assumptions behind appraisal methods

Methods of evaluating the environment in monetary terms may be influenced by ethical and moral value judgements. Value judgements may also mean that in particular instances

the appraisal of environmental effects in monetary terms may be rejected. It is important to maintain an open attitude here. It must be made clear what social and political assumptions correspond with the choices in the methodology of the cost-benefit analysis, and how. The complexity of the policy issue and the reliability of the appraisal methods used in part determine the role which the MKBA can play in policy formulation.

Environmental policy has ethical aspects which lend themselves less well to cost-benefit analysis. It is for example possible that particular norms of decency or principles in environmental policy (the standstill principle) cannot be defended from the viewpoint of costs and benefits, but they are nonetheless justifiable in a general sense. As an illustration, it may be legitimate within the framework of costs and benefits to permit liveability standards to be transgressed in particular places, while this is not justified from the viewpoint of decency and reasonableness. A further example is Brent Spar. Sinking this drilling platform at sea was probably a sound solution from an environmental viewpoint. But it conflicted with the major efforts of governments to introduce producer responsibility for waste and residual emissions. The question is whether and how the possible conflict with normative principles in environmental policy should be explicitly included in concrete *MKBA*'s.

- Are there legitimate reasons to allow deviations to discount rates (including risk premiums) for issues relating to the environment and sustainability?
- In terms of policy for which the benefits lie in the distant future, an important consideration is how the future benefits can be assessed. There is considerable discussion on the discount rate in relation to intergeneration distribution issues, and there are a number of different approaches and lines of thought in academic circles. Which approach should be adopted in order to determine an optimum discount rate? Is it possible to select one approach or does this depend on the type of problem or source of funding?
- In terms of policy that aims to influence the selection process for technology and/or technology development, it is equally important to assess the costs of such policy. Where environmental policy aims to reduce uncertainty in terms of future risks (climate), the question of how risk premiums should be handled is no trivial matter. For policies where the costs are borne by both private and public parties, a by no means unimportant consideration is how to handle the higher rate of returns demanded by capital markets for high risk investments.
- What role should *MKBA*'s play in decision-making processes on environmental and sustainability policy?
- To what extent should the uncertainties surrounding the outcomes of (complex) *MKBA*'s, as well as the influence of value assumptions on the outcomes, influence the position of *MKBA*'s in decision-making? A background consideration is the question of whether *MKBA*'s should be made compulsory in particular instances.
- How should the at times broad spread of plausible estimates of the market value of both the costs and the benefits be handled?
- How will they relate to existing support tools such as the *MER* (Environmental Impact Report)? What is the relationship with existing legal analyses such as the business impact analysis? How will they relate to European Impact Assessments?
- What role can an *MKBA* play in the decision-making process? And at what point in time? How can policy-makers learn from the analysis contained in an *MKBA* (e.g. policy modification, phasing)?

- How should the *MKBA* research be presented (to avoid any misinterpretation)? Should a distinction be made between simple figure-based *MKBA*'s (data book containing only figures) and very extensive analyses (month-long projects by consultancy bureaus)?
- How can an *MKBA* be used externally: both in terms of the process as the results of *MKBA*'s (supporting policy decisions, creating support from players, politicians)? How can *VROM* or the Netherlands apply the *MKBA* instrument for European decision-making (influencing European *MKBA*'s and substantiating the Dutch viewpoint)?
- What can we learn from the experiences with the *OEI* (Overview of Infrastructure Effects) method?
- What can we learn from the experiences of other countries with prescribing *MKBA*'s, the appraisal methods and guidelines used there, particularly the US and the UK?
- In what policy areas can an *MKBA* be effective? In all areas, or is it possible to set priorities?

The questions cover a broad, but cohesive field. It is about both the 'world of measuring' (calculation models) and the 'world of weighing' (political considerations). These two worlds are inter-related in two ways:

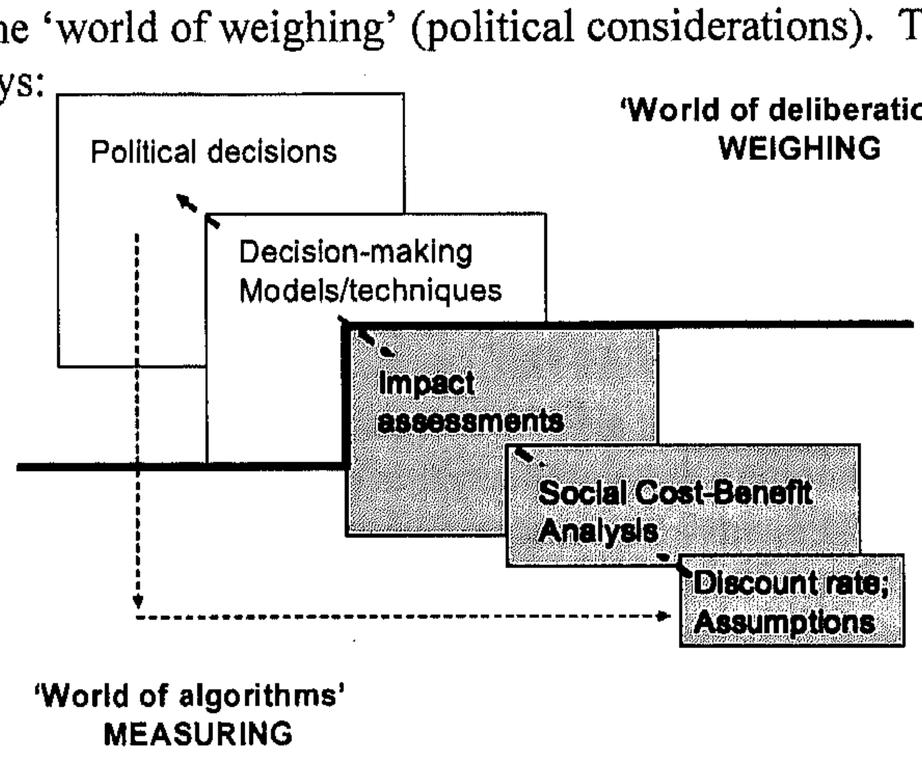

Diagram 1.1: Inter-relationship of themes within the project.

Financial models such as *MKBA*'s provide information to support decision-making. Assumptions in *MKBA*'s are sometimes political/cannot be said to be scientifically independent. In the interests of effective decision-making, in view of the assumptions to be made, it is important to make these explicit, therefore:

Political considerations lead to conclusions about assumptions to be used in financial models.

1.3 Approach to the project

There are areas of common interest between the two sub-projects (CE/guidelines and RMNO), and there is also the risk of overlap. The accepted results of this present advice will be included in the guidelines to be generated by the other sub-project.

External experts from the field, including from the Netherlands Bureau for Economic Policy Analysis (CPB) and from the National Environmental Policy Office (NMP), have been involved in both sub-projects. Interim workshops and an international scientific conference on this sub-project have taken place.

The question posed to the RMNO relates to a complex and so-called unstructured issue: the opinions of the parties involved, both from science and policy, differ both in terms of the facts and the values. This has had consequences for the organization of the project.[39] The project has therefore been structured along interdisciplinary lines.

The risk with an unstructured issue is that the whole project may remain caught up in discussions on values and the significance of the available knowledge. In order to minimize this risk, the responses to the research questions are continually focused on finding an **operational perspective** for the government.

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[39] See Hoppe and Huijs (2003): Working at the interface between academia and policy: Paradoxes and dilemmas, RMNO, The Hague; De Wit (2003: 213): New governance ideas and their consequences for knowledge management, research and innovation in the European Union. In 't Veld (ed.) (2000): Willingly and Knowingly.

Annex A-3 Project organisation

1. Team RMNO

Prof. dr. Aart de Zeeuw, prof.dr. Roeland J. in 't Veld
Project manager: Louis Meuleman; project team: Gerard Bartels, succeeded by Paul Hogewoning.
Tilburg University: Daan van Soest, Jasper de Jong.

*2. Sounding Board Group ****

Prof.dr. Aart de Zeeuw (Univ. of Tilburg; council member RMNO)
Prof.dr. Roeland J. in 't Veld (Chair RMNO)
Prof.dr. Marjan Hofkes (member VROM-Raad)

Centraal Planbureau (Herman Stolwijk – CPB)
Milieu- en Natuur planbureau (Sonja Kruitwagen)
Opdrachtgever VROM: Ben Geurts, Rutger Pol.

3. International scientific review team

Prof. David Ulph (University of St Andrews)
Tom Jones (OECD) (Univ of Calinfornia)
Prof. Michael Hoel (Oslo University)leidingscommissie

PART B. PROCEEDINGS OF THE SCBA CONFERENCE, 16-17 JANUARY 2008, THE HAGUE

1. Impressions of the presentations during the conference

Dinner speech 16 January by Mr. Harry Borghouts, Commissioner of the Queen in the Province of North-Holland, the Netherlands

At the beginning of his dinner speech Mr. Borghouts refers to the recently held UN Climate conference in Bali. Governments must and will take important and also financially substantial decisions on climate change projects in the near future. Therefore it is extremely important that governments are able to use the best available decision support methods and in that sense this conference could not be timelier than it is. Based on his own experiences (e.g. with Schiphol Airport, infrastructure and the protection against water) he has mixed feelings towards the use of SCBA as a decision support method. He is not sure that SCBAs always lead to better decisions. Do SCBAs really help to make better trade-offs between different goals and interests? Is it possible to explain and justify trade-off decisions with and SCBA and will the public in general trust the decision makers using SCBAs? Will the public believe that the best possible decisions are made in their interests?

In the opinion of Mr. Borghouts, there are several problems attached to the current use of decision support methods like SCBA. The first one is that sometimes different stakeholders, including governmental organisations, make their own SCBA, with highly contrasting results depending on the assumptions made. In the discussion on a high speed railway between Amsterdam and the Northern provinces, there were at least 8 SCBAs made. In such situations less consensus and more heavy opposition can be expected. A second problem rises when SCBAs are used as more than a supporting model: cost-benefit analysis as an alternative for political leadership. Governments must have the courage to, now and then, decide differently. Borghouts illustrates this problem with examples of the so-called Delta Works and the metro-systems of Paris and London. These infrastructure projects would most certainly never have been built when these decisions had been based on cost-benefit analyses. Strong public leadership has to play a major role in such cases.

Mr, Borghouts concludes that decision support methods as SCBA should be
Scientifically sound (in a multidisciplinary way: economics and other social sciences);
Politically transparent and manageable;
Acceptable for, and trusted by the public and societal stakeholders;
Developed under good process conditions.

These issues are also raised in the draft report and will be discussed at the working conference. Wishing his audience a very fruitful exchange of ideas, Mr. Borghouts expressed his hope that the results of the conference will increase his confidence in SCBA as a method to support long-term political decisions on issues like those related to climate change. Issues that have not only an economic component but also social, environmental and ethical dimensions.

Ir. Hans van der Vlist, permanent secretary, Ministry of Housing, Spatial Planning and the Environment

Different points of view have fuelled many heated debates about social cost benefit analysis in recent years. The focus of the speech of Mr. Hans van der Vlist is on the policy-related aspects of using the SCBA instrument in environmental policy.

In the Netherlands there are SCBA guidelines for infrastructure and also for environmental policy. It seems wise to get a good idea of the costs and benefits for major projects or plans. After all, many environmental measures also have profound economic effects and enormous social impact for instance when major housing projects are cancelled because air quality standards cannot be met.

Despite objections to SCBA in the academic field and in society on issues like valuation and discounting, the Ministry sees social cost-benefit analysis as a useful decision-making tool. But a transparent design is necessary, the assumptions underpinning the SCBA should be clear and SCBA does not replace political decision-making. Therefore the Ministry asked the Advisory Council for Research on Spatial Planning, Nature and the Environment (RMNO) to carry out a advisory study on complicated and fundamental issues as valuation, discounting and the role of SCBAs in decision making. Further the Ministry is conducting several SCBAs according to guidelines developed by CE consultants in Delft to gain practical experience.

The issue of the discount rate is heavily disputed and scientists are deeply divided, but it can have a decisive impact on the results of a SCBA and so it is of crucial importance for the every day business of political decision making. The RMNO report will be used as a basis for discussion over the next few months, and Mr van der Vlist hopes that the discussion will lead to a government position.

As regards assigning a value to environmental issues Mr. van der Vlist states that this happens also without an SCBA. Any environmental standard, by definition, implies a value against which something is judged or measured. Therefore, appraising the current and future benefits in terms of the environment, nature and health is important too. And although the constructed values by a variety of scientific appraisal methods will never reveal an objective and indisputable value that people attach to environmental benefits, they do allow us to make good estimates. We must accept that responsible scientific practice sometimes calls for qualitative descriptions instead of numbers and we should be open about uncertainties and margins of error. A good sensitivity analysis can be helpful too.

The key concern of government and politicians is whether a public intervention will increase the well-being of the citizens. To answer this question information is necessary but that information can never be complete and certain. While SCBAs can help to gather information in a structured structured, consistent way and can give a very valuable overview of all the relevant effects of a given measure or plan it are finally the politicians who have to decide weighing all relevant information. Social cost-benefit analysis should support and never replace political decision-making.

Finally Mr Hans van der Vlist believes that social cost-benefit analysis can be a valuable asset in decision-making, even if some methodological issues on valuation of environmental goods and services and discounting remain unresolved. The strength of SCBA lies in its consistent and structured delivery of information about a project's effects on all relevant measures of well-being.

An introduction to the RMNO report by Prof. dr. Aart de Zeeuw, University of Tilburg and Beijer Institute, Stockholm; Member of RMNO

Prof. Aart de Zeeuw introduces the report. There is an increasing demand for SCBAs and there are SCBA –guidelines in the Netherlands for infra-structure. The question is how to handle SCBAs for environmental issues and for other projects and issues when environmental issues are also at stake. The main intention of the report is to increase the knowledge base on topics as valuation methods for environmental goods and –services, discounting and the role of SCBAs in environmental policymaking. Practical guidelines can be found in the 'Leidraad MKBA in het Milieubeleid' developed by CE Delft.

Prof. de Zeeuw concludes, that:

- There are many decision support tools, for instance MCA and MER, but distinction is not productive and in his opinion the strong points of each method have to be integrated. Also the stakeholders have to be included in a SCBA.
- Attaching monetary values to physical entities is looking for indifference and he thinks this is a good way to make incomparable entities comparable. When attaching monetary values to different entities, the methods used must be state-of-the-art and 'weak parts' must be transparent.
- The 'contingent valuation method' is the only available method to elicit certain values and therefore there is a necessity to use it despite several weak points.
- The social discount rate is a better starting point than the market interest rate. A risk premium can be added to that social discount rate.

Comments by Prof. dr. Michael Hoel, University of Oslo

Prof. Michael Hoel presents an overview of his comments on the RMNO report, including the topics of the prices of non-market goods, the use of SCBA, discounting and uncertainty.

He makes the following statements in his presentation:

- To know prices is always relevant in trade-offs. It is difficult but possible to construct prices for non-market goods or services. Consistency in constructing prices for different types of public decisions is important and shadow prices from macro-economic analysis can be used in decentralized decisions.
- It is not obvious that a SCBA should incorporate as much variables as possible, because it makes the SCBA more complex and expensive. Therefore one have to make a choice which variables of interest for decision for decision making to include and it is important to communicate clearly about these choices as well as about uncertain and/or controversial variables.
- There are reasons for a declining discount rate over time.
- Only non-diversifiable risk should lead to an adjustment of the discount rate relative to the risk-free rate.

Comments by Prof. dr. David Ulph, University of S. Andrews

Prof. David Ulph describes the context and scope of environmental policy and emphasises emission quotas, carbon trading schemes, projects affecting wildlife habitats, energy – and transport policy, Research and Development and Tax Credits, and European Impact assessments. According to Prof. David Ulph:

- An important issue in a SCBA is whether prices (including taxes) capture externalities.
- There is no reason why discount rate should be constant over time.
- An SCBA depends on a number of judgements. How to treat different people and how to treat discount rates? Also value of information has to be weighed against cost. A SCBA is expensive.

Comments by Mr. Tom Jones, OECD

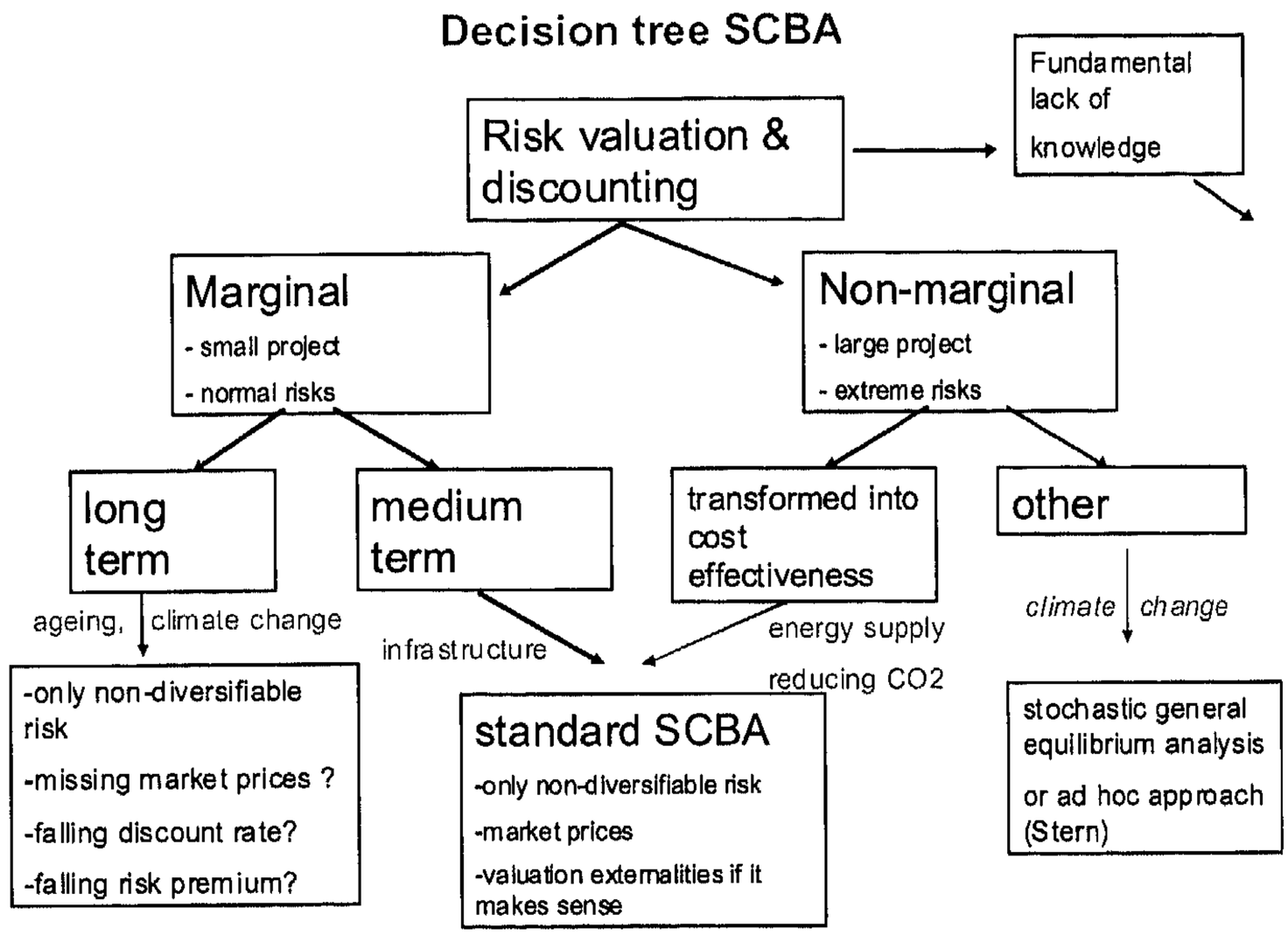
Mr. Tom Jones shared the following notions about valuation and discounting:

- CVM methods have been improved and there is wider acceptance. Consistency of the valuation methodology is important in his opinion. Problems are the sensitivity and the question of the possibility of benefits transfer.
- The actual practice of discounting is characterised by an inconsistent application of discount rates. Are declining discount rates or lower discount rates for environmental projects necessary. There is still a lot of discussion.
- Environmental problems are of a special nature. There is a need for stakeholder involvement and selectivity in a SCBA and the presentation and communication is key-factor.

Comments by Prof. dr. Casper van Ewijk, Netherlands Central Planning Bureau

Prof. Casper van Ewijk describes the practice on SCBAs in the Netherlands. SCBAs are performed by various research institutes and there are common guidelines for infrastructural projects. A difference has to be made between a quick scan and a full SCBA. Environmental SCBAs can be different in a number of aspects, but this is not necessarily so. Most environmental SCBAs fit in a standard approach and it is often possible to transform the problem into a cost-effectiveness approach.

Do we have to use different prices for environmental evaluation? The answer of Prof. van Ewijk is no: it is sufficient to use one price for time and risk (as for labour and bricks). That is just a condition for efficiency, but we must take into account the specific risk and time features of environmental processes. Also he does not agree with the proposition that a specific* social discount rate would be superior to a (social) discount rate based on market prices. It is general and therefore wrong in his opinion. In the end he proposes the following decision tree for SCBA:



Comment by Mr. Stephen White, DG Environment, European Commission

Mr. Stephen White brings in his experiences from the European Commission with Impact Assessments. Should we value non-market goods? His answer is yes, explicitly or implicitly. The framework of the European Commission is "qualitative, quantitative and monetary where possible".

Should we discount? His answer is also yes. The Commission uses 4% real but in there is no right answer in theory and practice. Very few policies are sensitive to impacts over more than 30 years in the future, however you discount them. In his opinion the following order of importance should be followed: Do an analysis – quantify as far as possible – have a discount rate – choose a discount rate. *???

At the end of his presentation he presents the following lessons (with a warning: what works in the Commission may not work here!):

- Multiple assessments confuse. Therefore it is best to integrate them into a single analysis.
- It is best to have a single system for all policy areas.
- Turkeys do not vote for Christmas (meaning: it should not be voluntary)
- Do not analyse just major policies (the choice is not between MCA and SCBA but about whether you want a proportionate analysis of all policies).
- There is a need for quality assessment internal at a high level and by stakeholders. Therefore it is necessary to publish the analysis.
- Impact Assessments and SCBAs should influence policy. Guidelines must be understandable for people designing policy. They must be common sense and free of economic jargon.

Comments by Mr. David Gee, European Environment Agency

The last presentation at the conference was held by Mr. David Gee. He starts his reflections on the discussions and the draft RMNO paper with the remark that there is a need for humility in face of uncertainty and ignorance. Acknowledging ignorance as well as uncertainty is part of a more humble approach to knowledge. According to Socrates "Wisdom is to know that you do not know". Scientists including economists should keep that in mind.

Mr. David gee presents "Twelve Late Lessons" from the "Early Warnings" (EEA, 2001) illustrated by examples and questions. The lessons are:

- Identify / Clarify the Framing and Assumptions
- Manage "risk", "uncertainty" and "ignorance".
- Identify/reduce **"blind spots"**.
- Assess/account for all pros and cons.
- Analyse/evaluate alternative options.
- Take account of stakeholders **values**.
- Avoid "paralysis by analysis" by acting to reduce hazards via the precautionary principle.
- Identify/reduce interdisciplinary obstacles to learning.
- Identify/reduce institutional obstacles to learning.
- Use **"lay", local** and specialist knowledge.
- Identify/ anticipate **"real world"** conditions.
- Ensure regulatory and informational **independence**.
- Long term monitoring /research.

Mr. Gee concludes with the following statements/questions:

- Qualitative judgements will often be more reliable than quantitative estimates and also qualitative costs may easily dominate other easily seen and measured costs.
- Only Relevance, not Precision is possible from Complex, Chaotic systems. Therefore "Pro & Con Analysis which includes qualitative items will often more robust and reliable than much conventional CBA"
- Marginal approaches to ecosystems valuation will often be inappropriate.
- Is marginal damage/benefit analysis suitable for the non-linear dynamics and thresholds of biological / ecological systems?
- Consistency is not always good. Inconsistency is to be expected from complex reality and diversity and not uniformity, improves the resilience of socio-ecological systems. Therefore, consistent assumptions/approaches of CBAs of diverse ecosystems may not be appropriate.
- "The Precautionary Principle provides justification for public policy actions in situations of scientific complexity, uncertainty and ignorance, where there may be a need to act in order to avoid, or reduce potentially serious or irreversible threats to health or the environment, using an appropriate level of scientific evidence and taking into account the likely pros and cons of action and inaction" (EEA 2002).

His final conscience question to audience is: Do we need more courageous judgement and action by decision makers (in a context of uncertainty, ignorance and non-linear systems) based on qualitative pro and con analysis in stead of more costly and often misleadingly "precise" and often politically ignored CBAs?

2. Commentary paper by Professor Michael Hoel, University of Oslo[40]

2.1 Introduction

My general impression of the report is that it is of high quality, and addresses most of the relevant issues related to the use of social cost benefit analyses (SCBA) for environmental policy making. My comments will be organized by topics, some of which are discussed at more than one place in the report. Moreover, while my comments to some extent address issues treated explicitly in the report, I also have some views that may be considered supplementary to the contents of the report.

2.2 Prices of non-market goods

On page 1 of the report three issues of particular relevance to SCBA of environmental problems are mentioned. The first of these issues is the issue of how environmental goods and services can be valued. This issue is part of the somewhat broader issue of prices (i.e. values) of non-market goods. One important non-market good that enters very many SCBA – both of environmental issues (e.g. climate) and of other issues (e.g. of investments in some types of transport infrastructure) – is human lives. The value of a statistical human life (henceforth VSL) is obviously a very difficult concept and not easy to place a number on, but the report argues that it is not impossible (in principle)[41]. Nor is it impossible to set an explicit price on several environmental goods. The report discusses these issues very thoroughly is section 2.1 and in chapter 3. The broad message is that it is possible – but difficult - to measure individual preferences over goods such as survival probabilities and environmental goods. I agree with this conclusion. But even in cases where the sum of individual willingness-to-pay (WTP) for such goods is so difficult to measure with reasonable confidence, prices on such goods may be used in SCBA. I shall illustrate this with two examples.

First, assume one needs a number for the VSL in a SCBA of some environmental problem. Even if standard procedures for measuring this price give a very uncertain outcome, the price used in the SCBA can at least be required to be consistent with the VSL implicitly used in other government decisions. Obvious examples of the latter are decions about security motivated road investments and decisions to use or not use advanced high-cost potentially life saving medical interventions. If one from such decisions could infer one number for the VSL, this price should be used also in the SCBA of the environmental problem. Unfortunately, there will typically be quite a broad range of numbers for the VSL when one considers several decisions of the type mentioned. But one should at least require that the VSL used in the SCBA of the environmental problem should be within this range.

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[40] December 2007. The page and section nrs refer to the Conference version of the RMNO report, which is downloadable at www.rmno.nl *

[41] In many SCBAs of transport infrastructure and of medical issues it is common to place an explicit value on life or of a life-year. See e.g. Johansson (1995) for an excellent survey of this topic.

The second example regards climate change. Assume Netherlands has a policy goal of implementing all climate gas emission reductions that are sensible form a global point of view. One way to proceed is to use some global macro analysis of e.g. the type reported by Nordhaus (2007). Given for instance the view that we should avoid global temperature increases larger than 2.5 degrees, analyses of this type give a shadow price for CO2 emissions. For this case The study mentioned by Nordhaus gives a price of 13 dollars (2005 US-dollars) per tonne of CO2 in 2015, rising to 39 dollars in 2055 and 168 dollars in 2105 (i.e. an average growth rate of this price equal to 2.8% per year). This price path gives a guide to how a tax on CO2 emissions should develop or to what CO2 quotas should cost now and in the future. Due to various types of market failures, there can be several policies directed towards reducing emissions (in addition to the price of CO2 faced by private agents). To evaluate such policies one can use a SCBA where reductions in climate gas emissions are given a value equal to the shadow price from the macro analysis. By doing this, one secures consistency about which policy proposals are accepted and which are rejected, and one also achieves consistency with regard to the emission reducing measures undertaken in the private sector as a response to the price (tax or quota price) it faces.

2.3 The use of SCBA

The issue of how a SCBA should be integrated into a decision making process in discussed in section 2.3 and chapter 5 of the report. For the hypothetical case in which all variables policy makers are concerned about are included in the SCBA and all estimated prices of non-market goods are uncontroversial, the result of a properly done SCBA is *all* that is needed to make a decision. In practise, these two assumptions are not valid, and perhaps less valid for environmental issues than in some other areas. Since some aspects of a problem in practise always will be left out of a formal SCBA, the SCBA will only be one of the inputs in the political process of making a decision. However, exactly what is included and what is left out of a SCBA is a matter of choice. On the one hand, one would like to include as many aspects of the problem as possible in the SCBA. On the other hand, some variables have much more uncertain and/or controversial values than others. Including these uncertain/controversial variables in the analysis may then reduce the value of the whole analysis, and thus make the part of the analysis that weights together various uncontroversial variables more or less useless. There is no general answer to this trade-off, but it is important that both analysts and decision makers give this issue proper thought before the analysis is done. If I understand so-called MCA correctly, it can be interpreted as a SCBA where only some of the important variables are included, while the remaining variables are reported separately. The problem with this type of analysis is that if there are too many types of variables that are omitted from the formal CBA, a decision must be made based on a large range of variables. This might force the decision maker (or analyst) to put weights on different elements, but if this is done one might as well use these weights as prices and include the variables in the SCBA.

Almost all SCBA will include some uncertain and/or controversial variables, of which the discount rate may be one. For a SCBA to be taken seriously, the bases for these variables must be carefully communicated, and results of the SCBA should be given for several numerical specifications of the most uncertain/controversial variables. Also, it is obviously desirable to include the decision maker in the process of giving these variables specific values (as argued in chapter 5).

2.4 Discounting

In Section 1 of the report it is argued that one of the issues of particular relevance to SCBA of environmental problems is the issue of discounting. The choice of the discount rate is important in *all* SCBA, but since at least some environmental problems have a very long time horizon (e.g. the climate problem) the choice of the discount rate is particularly important for such problems.

In section 4.7 of the report an argument is given for using a declining discount rate. I do not disagree with this (se my comments below), but it should be made clearer exactly what is meant by this. (The authors might think it obvious, but I am not sure all readers will.) Consider table 4.2 in the report (discount rates used by the UK government). In particular, the table reveals that a discount rate of 3.5% should be used for 0-30 years, but only 3.0% for 31-75 years. What is important is that this does *not* mean that one should use a constant discount rate throughout the calculation period for projects lasting from 31 to 75 years.[42] What is *does* mean is that for a project lasting say 50 years, costs and benefits incurred during the first 30 years should be discounted at a rate equal to 3.5%, and that costs and benefits for the remaining years first should be discounted back to year 30 at the rate 3.0% per year, and then discounted back to year 0 (the initial date) at the rate 3.5% per year.

In the report, the main reason given for a declining discount rate is the argument first presented by Weitzman (1998), see also Weitzman (2001)[43]. There may be other arguments. It is useful to start with equation (4.1) in the report which I rewrite as

$$(1) \quad r(t) = \rho(t) + \mu(t)g(t)$$

In principle, all of the three parameters/variables on the r.h.s. of (1) may change over time. The question is whether there are good reasons to believe that at least one of these parameters/variables decline systematically over time. One issue is what type of preferences (1) express. In a relatively short time span (up to about 20 years) the tradeoffs over consumption at different time points are mostly within the same generation, i.e. the same group of persons. In this case both ρ og μ are properties of the preferences of these persons. On the other hand, for a time perspective of 50 years or more the tradeoffs between different time points is a question of distribution between generations. In the report (and elsewhere) it is argued that in this case ρ ought to be close to zero, as it is difficult to give a good ethical justification for treating people of different generations differently just because they have different birth dates.

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[42] To see that this would be meaningless consider two projects A and B that are identical for the first 30 years, with an initial investment and then positive benefits during 30 years. For project A there are zero costs and benefits after the first 30 years, while B has a small closing cost at year 31. Clearly, A is better than B. But if one uses a 3.0% interest rate for B (since it lasts 31 years) and a 3,5% discount rate for A (since it lasts only 30 years), the present value of B will be higher than for A if the closing costs are sufficiently small!

[43] In addition to the theoretical analysis, Weitzman (2001) gives a numerical estimate of how fast the discount rate should decline. The estimated decline in the discount rate is considerably steeper than in the UK recommendation (table 4.2 in the report).

If one accepts this argument and people in their preferences regarding their own consumption over their lifetime have a relatively high value of ρ, this is an argument for a lower discount rate for the distant future than for the near future.

It is not obvious to what extent the parameter μ differs between preferences within generations and preferences across generations. It is in any case useful to be aware of the interpretation of μ: It is a measure of how rapidly the marginal utility of consumption declines as consumption increases. In particular, if $\mu < 1$ a 10% increase in consumption starting from a high consumption level is considered better than a 10% increase in consumption starting from a low consumption level. Conversely, if a 10% increase in consumption starting from a high consumption level is valued less than a 10% increase in consumption starting from a low consumption level. In the context of intergenerational distribution decisions (or more generally of distributions across any different groups of persons), this means that if one is "God" and is given the power to give some group of persons a 10% increase in their consumption, one would prefer to give this to persons with high initial consumption rather than to persons with low initial consumption if $\mu < 1$. If on the other hand $\mu > 1$ one would prefer to give persons with low initial consumption a 10% increase rather than to give persons with a higher initial consumption a 10% consumption increase.

The parameter μ is often interpreted as a measure of risk aversion (see e.g. last half page of section 4.2 in the report). This is however only correct for a particular separable specification of preferences (which is the specification most often used in economic analyses). More generally, the parameter μ used in an intertemporal context need not have anything to do with a decision maker's attitude towards risk. In particular, we could imagine two decision makers who make the same intertemporal choices in cases of certainty, but who would make different choices in issues involving uncertainty.

Returning to equation (1), the growth rate $g(t)$ need not be constant over time. During the last 50 years the average growth in consumption per capita has been about 2,5% per year (world average). This is unusually high in a long time perspective, and there may be several reasons to believe that this growth will not be so high the next 100 years. If e.g. the consumption growth rate gradually declines towards 1% per year, this will give a gradually declining discount rate.

Equation (1) is derived from an analysis that disregards uncertainty in the growth rate $g(t)$. Assume instead that the consumption growth rate is stochastic and normally distributed with an expected value of g and a standard deviation equal to σ. Then equation (1) will be changed to (ignoring time references)

$$(2) \quad r = \rho + \mu g - \frac{1}{2}\mu^2\sigma^2$$

One set of numbers presented in the report (section 4.6) are from The UK Green book: $\rho = 0{,}015$, $\mu = 1$ and g=0,02. Without any uncertainty regarding the growth rate (i.e. $\sigma = 0$), the discount rate is in this case 3.5%. With uncertainty and a standard deviation of $\sigma = 0{,}02$ the discount rate is reduced to 3.46%, i.e. an insignificant change compared with the case of no uncertainty. It is reasonable to believe that the uncertainty about the growth rate of the economy is larger the further into the future we look. This draws in the direction of a declining discount rate, but the increase in the uncertainty measured by the standard deviation must be quite large for this effect to be important.

A weakness with equation (2) is that it assumes that we know the probability distribution for the economy's growth rate in the future. Weitzman (2007) has argued that when also the probability distribution for the growth rate is uncertain, the discount rate can be strongly affected by this uncertainty. In particular, he argues that in a time perspective of more than a hundred years we cannot disregard catastrophic events implying that the average growth rate from today to this future date can become negative with a large numerical value. Even if the probability of such an event is very small, the possibility of such an event can imply that the correct discount rate is negative with a large numerical value – in his formal analysis "minus infinity". This latter result should not be taken literally, but the point of the analysis is that the correct size of the discount rate may depend strongly on what we assume about the probabilities of such catastrophic events. We probably "know" much more about such probability distributions for the near future than we do for periods 50-200 years from now. This argument thus supports an assumption of a declining discount rate, and perhaps declining quite sharply.

In the last half page of section 4.7 it is argued that a declining discount rate may imply dynamic inconsistency, in the sense that if one is allowed to reoptimize at some future date one would want to revise the original plan made for the future. However, this need not be a sign of any type of irrationality. Assume e.g. that the declining discount rate is due to either a declining expected growth rate g or an increasing uncertainty about this growth rate. If this is the case and one reoptimizes at a future date it may be optimal to stick to the original plan if one's expectations about the growth rate are confirmed. It may also be the case that at the future date we have more information about the growth rate, and in this case it may make sense to revise the original plan in light of this new information. A more fundamental issue is of course that if we expect to receive more information in the future this should affect our decisions already "today" in the direction of giving flexibility an option value (as discussed in the section 4.5 in the report).

In summary, there seem to be several good reason why the discount rate should be declining over time. However, a much more difficult question to answer is how rapidly the decline rate should be.

2.5 Uncertainty

I do not have much to add regarding the issue of how uncertainty should be treated (section 4). The report correctly point out that uncertainty should either be treated through an appropriate adjustment of the risk-free discount rate or use the risk-free discount rate and explicitly include whatever uncertainties there are in the analysis. However, it is important not to use both methods, and thus get a "double-counting" of uncertainty. In particular, if uncertainty is included through an appropriate adjustment of the discount rate, it is important to use expected values for the variables entering the CBA. As the report points out, it is only "non-diversifiable" risk that should lead to an adjustment of the discount rate relative to the risk-free rate. In particular, for a project giving a return that is positively (negatively) correlated with the general future consumption level (or more generally, welfare level) one should use a discount rate that is higher (lower) than the risk-free discount rate. For several environmental projects it may be difficult to know whether the value of the project is positively or negatively correlated with general consumption. To see this, consider some project where an important part of the benefits are reduced greenhouse gas emissions. These should be valued at a price as explained in my section 2. However, this price will be uncertain. What should the discount rate be? Assume first that the most important uncertainty about the future consumption level is about the general productivity growth. A high productivity growth will give high consump-

tion in the future. However, it will also give a high future value of greenhouse gas emissions for two reasons: First, higher productivity growth will typically give larger emissions, and if environmental damages increase more than proportionally with emissions this tends to give a higher price of emissions. Secondly, higher productivity growth gives higher income and thus, provided the environment is a normal good, a high WTP for reduced emissions. So in this case the returns to the project are positively correlated with the general consumption of the economy, and the discount rate used for the project should be higher than the risk-free discount rate.

An alternative source of uncertainty about future consumption – or more generally future wellbeing – could be the consequences of greenhouse gas emissions. There are large uncertainties both about what climate changes will follow from a given atmospheric stock of greenhouse gases, and also about the economic consequences of a given climate scenario. The worse are these climate change effects, the lower will future consumption (or wellbeing) be. Moreover, the worse the consequences, the higher is the value of reducing emissions. In this there is therefore a negative correlation between the benefits of the project and the general consumption level. The discount rate used should therefore be lower than the risk-free discount rate.

From the example above it is clear that it is not at all obvious what discount rate to use for environmental projects with an uncertain return. In the example above the answer depends on which source of uncertainty one believes is most important for the general future well-being; is it the rate of general productivity growth or is it climate change induced future consumption losses?

2.6 Additional comments

Several places in the report there are formulations indicating that SCBA are biased due to a high discount rate (p. 34, p. 37, 53). This is not true. There is nothing in the SCBA itself saying that the discount rate should be high. However, there are good economic reasons for choosing a positive discount rate, although it is not obvious exactly what the rate should be. Moreover, an important and fundamental insight from economic theory is that *all* projects of the same risk class (environmental and other) should face the same discount rate structure. This might be a constant discount rate, or it might be a declining rate as discussed in my section 4. Risk considerations and time horizons may thus affect the discount rate, but whether the project is of an environmental type or not is irrelevant for the discount rate.

Related to the above, it is not necessarily true as claimed on p. 34 that positive discount rates of reasonable magnitudes imply that we "practically ignore the remote future" or that (p. 37) "actions that cost money now but will benefit future generations are likely not to be undertaken as a consequence of discounting in a SCBA" or that (p.53) "SCBAs have contained biases such as high discount rates, that makes any long term investment look unwise". The discount rate (applied to "general consumption") is only one of the relative prices that enter a SCBA. The development of the price (or valuation) of environmental goods relative to general consumption is an equally important variable. As pointed out in Hoel and Sterner (2007), this price change could have an effect that is as strong or even stronger than the discount rate itself.

The discussion of the example around equation (4.3) is unclear: The risk-free interest rate r applied to expected values of costs and benefits gives the correct result.

The example in section 4.3 p. 42/44 is correct and demonstrates that uncertainty can increase the expected net present value (ENPV) of a project if the correct choices are made. An important insight from this example is that with the appropriate choice today we learn something that can be used to make a good decision sometime in the future. The example also illustrates a more general important point. From an economic point of view, a necessary condition to recommend a project is that it has a positive ENPV. However, a positive ENPV is not sufficient: The project must also have a higher ENPV than any alternative projects that are excluded by undertaking the project under consideration. In the example, developing the land for agriculture excludes the project of not developing now but making a decision in the future. We find a similar point for many types of projects: Undertaking a project today means that we cannot simultaneously wait for some years and then undertake it. Learning, technology improvements and price changes are factors that can make a project with a positive ENPV be inferior to the same project delayed some years. Recall that the value of reduced greenhouse gas emissions are typically rising over time. A project of e.g. introducing mandatory use of biofuels from today onwards may have a positive ENPV. However, the present value (discounted to today) of introducing mandatory use of biofuels in 10 years time might have an even higher ENPV. If so, one should wait 10 years before introducing the program of mandatory use of biofuels.

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3. Commentary paper by Professor David Ulph, University of St Andrews

3.1 Background

1. RMNO was asked to produce a report for the Dutch Environment Ministry on the use of Social Cost Benefit Analysis (SCBA) in environmental decision making, and, in particular to address three questions:

What are best valuation methods?
How to deal with discounting?
What should be the role of SCBA in environmental decision making?

2. I have been asked to comment on the report. I will divide my comments into four sections, which broadly correspond to Chapters 2 – 4 of the Report:

the scope of environmental policy making and SCBA;
valuation issues;
discounting;
the role of SCBA in environmental decision-making

3. Let me begin by saying that I felt the Report did a very good job of addressing the questions raised. Rather than listing all the points of agreement, the general thrust of my comments will be to emphasise points and issues that I feel have been insufficiently addressed or brought out in the Report.

A. The Scope of Environmental Policy Making and SCBA

4. I start with question of what constitutes environmental policy-making and just note that while there are many policies that are clearly environmental and would fall within the scope of an Environmental Ministry to design and administer – the introduction of emission quotas; the design and administration of carbon trading schemes - there are many policies that have significant environmental impacts that will fall under other ministries to design and administer. Some obvious areas are energy policy – the use of nuclear power, introduction of offshore wind-farms - and transport policy – expansion of major airports, road-building programmes. Here policies have multiple aims of which environmental considerations may be part. For example energy policy is designed with a view to providing additional sources of energy to sustain economic activity but increasingly also considers the impact on the level of greenhouse gas emissions. Moreover these policies will typically have multiple environmental effects – e.g. the building of offshore wind-farms will have impacts on sea mammals and bird-life as well as on the level of CO2 emissions, While everyone expects that major energy and transport policies would require serious environmental impact analysis (and probably the use of SCBA) there are other policies whose environmental impacts may be less obvious. For example policies such as R&D tax credits designed to promote innovation can

have far-reaching impacts on the costs of various goods and services and potentially encourage greater transportation of raw materials and final outputs with consequent implications for carbon emissions. How far should this type of policy be subject to a full-scale environmental analysis? The answer relates to the second point I want to make below, but I just note that many governments now require **all** ministries to subject **all** their major policies to some kind of environmental impact analysis. The key point is that I think it would have been helpful if the Report had said a bit more about what it thought was the scope of environmental policy and the potential ministries that might have to think about using SCBA.

5 I think it would be useful to identify upfront two different types of environmental impacts which policies can generate and which policy decision tools will typically have to deal. The first is what we can think of as **direct** impacts **on** the environment - e.g. the impact of offshore wind-farms on sea mammals and bird-life – where typically the features of the environment being affected are un-traded and un-priced - while the second is **indirect** impacts **via** the environment - e.g. the impact of off-shore wind-farms on CO2 emissions – where the ultimate impact may be on economic activities that are traded and priced but where these impacts (externalities) are not correctly reflected in the prices consumers face for energy and transport etc.

6. A related point is the following. The Report emphasises the concept of indifference as underlying SCBA. While I don't disagree - though a more technical but precise term will often be the Marginal Rate of Substitution (MRS) - I think the report needs to emphasise more strongly the fact that where goods and services are traded individuals equate the MRS to the relative prices they face, so in many cases we can infer the MRS from market information on prices[44]. The real issue then is how far these prices already reflect marginal damage caused by the externalities of the traded goods. Put differently the fundamental issue in SCBA is how far one needs to go beyond normal commercial calculations of profitability in assessing policies. The principle is that what policy-making needs to calculate are the **uncorrected** externalities. For example consider a policy of building an extra runway for an airport to increase flight capacity where these additional flights will create additional pollution – noise and CO2 emissions. Suppose the government has imposed a duty on every flight that takes off[45], then how far does this obviate the need to undertake a SCBA of the policy of extending the airport? Some of the issues that need to be considered are:

How does the duty relate to marginal damage[46]?

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[44] To be fair this is clearly the implications the Report wants us to draw from the discussion on the value of life on pp5-6.

[45] In the UK we have Air Passenger Duty which is imposed on each traveller that flies – not quite the same thing.

[46] It may be argued that this is hard to determine unless one knows what marginal damage is and has undertaken the SCBA – but a previous SCBA could have determined this.

Even if duty is approximately equal to marginal damage does it matter that this duty was imposed just as part of a general policy of raising revenue at least cost by spreading the tax burden wider?
If duty is less than marginal damage but the government does not want to raise it further because, in the face of other policy restrictions, it is concerned about the impact on competitiveness, does the fact that this policy has been optimally chosen mean that SCBA is unnecessary?

Returning to the point raised in para 4, it would be appropriate to ignore environmental considerations when thinking of tax credit policy if one felt that environmental policies were such that marginal damage was adequately reflected in the prices consumers paid for their products.

Valuation

7. This section of the report focused almost entirely on the valuation of un-priced environmental assets, rather than the issue of valuing externalities. This may reflect the remit that was given. I thought this was very well done and that there was a very clear picture given of rapidly improving techniques with clear lessons. However there are four issues that could have been given more discussion.

8. In Section 2 of the Report there was a very useful discussion of the difference between policies that have just a fairly marginal impact on the level of some environmental asset or pollution level – where all one needs is a measure of the *level* marginal damage at existing levels of the environmental asset/pollution level – and policies that have a very significant impact on the level of some environmental asset or pollution level, where one needs a better understanding of the marginal damage function – i.e. how the level of marginal damage varies between the existing stock of the asset/pollution and the level of the asset/pollution that will prevail after the policy has been implemented. The obvious point is that since the latter is a hypothetical level, it is only techniques such as CVM that are capable of identifying this. However while the discussion in the report was couched very much in terms of valuing an environmental asset, it would have been useful to have more discussion of how well CVM techniques work in the context of pollution levels.

9. A related point is to consider the dynamics of valuation. If one considers building an airport that generates noise pollution over very long periods of time, one wants to know how willingness to pay for noise reduction will vary over time as peoples' incomes grow. It would have been useful to have some reflection on which techniques are best suited to picking up this issue. The issue is raised in section 4.8 in the context of the discussion of discounting, but it would have been useful to tie the discussion more closely to the methodologies for valuation being discussed in section 3.

10 Related to this, in Section 2 the Report identifies the potential problem that arises because the monetary value that people place on their own lives and environmental amenities varies with income with richer people placing a higher value than poorer people. The Report says that "in the design phase of policy making it may be important to distinguish these values in order to enable decision makers to choose how to handle these differences". I thought that more could be said about this – if only to give decision-makers more guidance. As the

report emphasises the monetary value that an individual places on their own life can be determined by thinking about the concept of indifference or, as I called it, MRS. This is effectively the relative price, denominated in units of money, that the individual is willing to pay to reduce the risk of early death. If we want to use this technique for making judgements about how much value society places on the lives of a diverse group of people, we have to say how much society values the income of a rich person relative to that of a poor person. The normal assumption is that in any society that displays an aversion to inequality society would place a higher value on an additional unit of income given to a poor person than to a rich person. Formally, if $MSVL_k$ is the marginal social value of the life of individual k, $MSVY_k$ is the marginal social value of the income of individual k, and MYL_k is the marginal valuation in terms of income that k places on his/her life then

$$MSVL_k = MSVY_k.MYL_k$$

The important point is that the fact that a richer person puts a higher monetary value of their life does not necessarily imply that society does. So to reach decisions, one inevitably has to make value judgements about how the marginal social value of income varies with income – how fast it falls as income rises. There are useful thought experiments such as Okun's leaky bucket that help think about this. This value judgement is intimately bound up with the parameter μ that appears in Section 4 of the Report, which can be thought of as the percentage reduction in the marginal social value of income as income rises by 1%.

11. Finally, a further point that relates to the weights one places on the valuations made by different people, I thought more needed to be said in the report about transboundary problems

Discounting

12. I do not have a great deal to add on this section, and there are just four points that I would like to make.

13. In section 4.6 it is argued that from a normative point of view the pure utility discount rate should be zero since all generations count equally. I know this argument is often used but I think it is wrong. Clearly if the consumption opportunities that the economy presented to different generations were perfectly symmetric then using a welfare function that treated generations asymmetrically would produce outcomes that were unequal but in a way that was quite unwarranted. However economies do not produce symmetric inter-temporal opportunities across generations. Because of the benefits of capital accumulation and technical progress consumption opportunities are slanted towards the future – though one's view on this might now be affected by the threats posed by climate change. In this case maximising an unweighted welfare function will produce asymmetric outcomes that favour future generations. There are two ways of producing outcomes that are more equal. One is to increase the inequality aversion parameter μ referred to above – but this may produce a value of μ that is inconsistent with one's intra-generational value judgements about the importance of equality. The other is to introduce utility discounting so as to "correct" for the bias introduced by tech-

nical progress etc. What this suggests is that rather than conducting a debate about what is the "correct" set of parameters (ρ_s, μ, g) to use in decision-making in an intellectual vacuum, a useful approach is to try to characterise the opportunities open to a modern economy in terms of technical progress, exhaustible resources, climate change etc. and then look at the implications of using different parameters on the utility levels accruing to different generations and form a judgement about whether the resulting degrees of inequality are unacceptable.

14. I think it is important to recognise more clearly that the numbers used in the Stern Review have been very strongly criticised by leading scholars such as Weitzman, Nordhaus etc.

15. I think that in section 4.5 it would have been useful to bring out more clearly the fact that what is being considered is a form of irreversible investment decision, which is why there is such a great value to postponing the decision pending the arrival of new information. The whole issue of the importance of irreversibility considerations to environmental policy-making could then have been explored more systematically – just what types of environmental considerations are likely to be irreversible and what precisely are the prescriptions for decision-making of the environmental irreversibility.

Use of SCBA as decision tool

16. I agree very much with the thrust of the report that it is wrong to think of the issue of SCBA's place within the range of decision tools available to decision authorities as being an either/or one. It is very unlikely that SCBA will be able to quantify and value all the outcomes of a particular policy (or even all the major outcomes), and even for those which it can quantify there will sometimes be a range of numbers reflecting both various uncertainties but also some areas where value judgements need to be made – see, for example the above discussion on different weights to be put on the values of life of people with different income levels. So SCBA is unlikely to give a single number and will produce a range of unsettled issues that still have to be decided. The decision-maker is inevitably faced with a MCA situation.

17. What SCBA is useful for doing is narrowing down the range of uncertainties. For those aspects of the policy on which it has been able to determine a (range) of value(s) it helps challenge if not eliminate claims to the effect that the value of certain outcomes is infinite. In the case of factors on which it has been unable to place a value it provides the decision-maker with a lower or upper bound on just how large these unvalued effect would have to be before they would overturn the decision the would emerge on the basis of the SCBA.

18. There are however a number of additional points that could usefully be added o the discussion in the report.

19. In deciding what decision tool to use, I think it is important to distinguish between a policy that impacts on a very specific environmental amenity – e.g. the decision to build an airport extension that will destroy a very specific and relatively unique wildlife habitat - and a policy that will involve an environmental impact that is likely to be common to many future policies – e.g. a policy that will have an impact on the level of CO2 emissions.

20. Given the expense of a Contingent Valuation study, the decision to undertake a SCBA in the case of a one-off policy should be based on some assessment of the value of getting information that will reduce some of the uncertainties in the decision. So one ought to have in mind what are the potential range of values that a SCBA might produce and how likely it is that the policy decision would be any different depending on the outcome of the study.

21. However there could be real value in conducting a study of the marginal damage of CO2 emissions because this plays an important role in many policy decisions. While there are important administrative issues about who would commission and pay for such a study the important issue is that the study is designed in such a way that the answer can carry across many decisions.

22. A related issue is that there are certain decisions – e.g. about certain features of discounting, about what value judgements/weights to place on the different values of life generated by people with different incomes - that are going to be common to many SCBA exercises and that should be settled once and not re-investigated in different policy decisions.

23. Taking these last two points together I think it is important to think rather more strategically than the Report does about the decision on which tool to use.

4. Commentary paper by Mr Tom Jones, OECD

Overall, we found the paper to be well-researched, well written, and presented in a very interesting way. Our specific comments are provided below; some (very light) editing comments are provided in the attachment. The following comments reflect the combined views of myself, and three of my colleagues here at the OECD (Nick Johnstone, Nils Axel Braathen, and Ivan Hascic – to whom I am indebted).

4.1 Introduction

The Ministry's own Objective Statement for the VROM paper is commendable. We have taken a similar approach in our emerging OECD Framework on Effective and Efficient Environmental Policies – where we seek to embed the SCBA logic firmly into the process of setting environmental objectives.

David Pearce *et al.* wrote a book for us a couple of years ago called *Cost-Benefit Analysis and the Environment: Recent Developments*. This book reviewed the full range of issues associated with CBA, and it is encouraging to see that much of the material in the VROM paper comes from (or is at least consistent with) the Pearce book. But one general comment is that, because the VROM paper focuses mainly on three of the key issues involved in SCBA (valuation, discounting, and integration), it seemed to lack some of the structure that had been embedded in the Pearce book.

One consequence of this was that we weren't always sure what the goal of the VROM paper was. Sometimes, it seemed to be to "develop practical guidelines"; at other times, the goal seemed to be to "clarify complex concepts". Nor was it always clear who the target audience was intended to be. At times, the text seemed to be addressing CBA analysts; at other times, it seemed more focussed on Ministry of Environment officials; at still others, it seemed aimed at the public-at-large. We ended up concluding that it could use some focussing of both its objectives and its target audience. If the goal is really to develop practical guidelines, everything in the paper should move toward this goal. (For example, we did not find the "Athena/Eukrates discussion" later in the paper very useful[47]).

4.2 Context

This text is well-written. One comment is that there are a few "general background" ideas contained in the Pearce Book that aren't highlighted here, so you might reflect on whether or not they should be. Possible candidates include:

SCBA has developed a lot in recent years, both in terms of the theory and the practical case studies. SCBA is now recognised as the major appraisal technique for public investments and public policy.

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[47] (Editor: This discussion was left out in the final version)

What Decision Rule lies behind SCBA? ("If a positive NPV exists, the project should be implemented").
The question of "standing". (Whose benefits actually matter?).

At the end of Section 2.1, the paper branches off into a discussion of the differences between SCBA and MCA. Three comments here:
It isn't obvious why this discussion should appear here. The main point to make is that SCBA works with indifference curves and other approaches do not. There is no particular need to focus on MCA.
If you do want to discuss the MCA approach, you probably need to get further into it than is done in this draft. For example, you might point out that (i) values in the MCA process are determined subjectively by the analyst -- not objectively by those who would be affected by the policy; (ii) MCA cannot handle the discounting problem at all; (iii) MCA can not tell you if any policy is needed – all it can do is rank policy options.
The last sentence of the Section ends with the phrase "…so that an important advantage of MCAs is preserved". Ending the discussion in this way suggest that you have a preference for MCA (which is probably not the impression you want to leave with the reader). Perhaps a better formulation would be along the lines of "…MCA could always be done at a later stage in the analysis".

4.3 Valuation

Introduction

We found the "direct/indirect" terminology confusing, and would prefer that you stick with "stated preference/revealed preference" throughout.

Section 3.4 seemed to be more than a "brief presentation" of the indirect methods. It could be shortened even further.

Your introductory Para. seemed to hesitate about whether or not CVM is the right way to go ("… at least in theory; …. "whether or not this technique can be expected to produce reliable results is questionable…"). In our view, there are ways of solving the main problems with CVM, so you should not be so hesitant to express support for this approach. Unless you are clear on this issue, you aren't really giving very much "guidance" to policy-makers.

Measuring the MAC functions

In the first Para., you say that "…environmental policies may worsen existing distortions in the economy". This seems a bit cryptic; on at least two counts: (i) given that environmental policy is typically aimed at *removing* existing distortions in the economy, many readers will find it confusing that your text goes in the opposite direction; (ii) the point you are making actually has to do with the "general economic" distortions generated by an eco-tax, and all the related arguments about possible "double dividends". This sentence therefore hides a lot of things, and should probably be expanded upon, to make things clearer.

Oosterhuis (2006) did find that ex post *costs* to business were only half of ex ante expectations. But that study did not point out that the ex post *benefits* of policy intervention were also only half of ex ante expectations. This meant that the costs per unit abated were roughly in line with ex ante expectations.

Measuring the marginal damage functions

The terminology with which we are more familiar to describe non-use values would be "option values; existence values; bequest values".

Our sense is that there is too much emphasis here on the revealed preference methods – especially if the "bottom line" of the paper is that CVM is a useful way to go.

It isn't clear what you mean by "Great care should be taken to eliminate these misleading answers", so we adjusted the text to "care should be taken…"

Stated Preference Methods: CVM

"CVM seems to be most accurate for publicly–managed goods with private characteristics, such as natural sites…" It may be most accurate for these situations, but does this mean that these are the only situations in which you would advocate the CVM approach?

The guidelines offered on Pages 30 and 31 are useful. More of this approach elsewhere would enhance the overall readability and utility of the paper. The conclusions at the end of Section 5 seem more "positive" about CVM than some of the text that has preceded these conclusions. So some "retuning" of the paper's messages may be appropriate.

Some basic ideas (about valuation) contained in our *"Framework"* document that are not yet emphasised in the VROM paper include:

Are the costs, benefits, and resulting policy objectives periodically revisited, to ensure that policy goals remain valid over time?
In conducting cost-benefit analysis of environmental objectives, is the focus placed on environmental outcomes (e.g. actual changes in air, soil, and water quality) – and on the impacts of these outcomes, e.g. in terms of changes in health conditions – rather than on "outputs" or "practices"?
Is a life-cycle perspective used in the estimation of the marginal costs and benefits of proposed environmental policies?
Are independent analysts involved in the preparation or review of cost-benefit analyses?

Some basic ideas (about valuation) that are contained in the Pearce book that are not yet emphasised in the VROM paper include:

There seems to be no mention of the need for sensitivity analysis in the computation of marginal costs and marginal benefits.
Pearce suggest that you should use median values for costs and benefits (not mean values) – in order to avoid giving too much weight to outlier views.
The benefits transfer issue is another key issue (especially in terms of keeping the costs of doing SCBA analysis down). Pearce *et al.* are bullish on benefits transfer, but argues in favour of a cautious approach – and one that makes the underlying assumptions/methods quite explicit. From our perspective, the main difficulty lies in deciding ex ante if benefits transfer will be appropriate (and when it will not).

4.4 Discounting

Project evaluation by firms

The discussion of "non-diversifiable risk" here is especially interesting.

The example of "termination risk" used in this discussion should probably be more "environmental", given the subject of the paper. The risks associated with the deglaciation of the Western Antarctic might be appropriate.

On the risks associated with "variances in the net benefit flows", the key point is the extent to which potential returns on the project will "track" returns on the economy as a whole. For a "small" environmental problem (i.e. protecting the snail darter), there is no reason to expect any particular correlation (either positive or negative). However for a "big" environmental problem (e.g. climate change, biodiversity), the returns *are* likely to be (positively) correlated – and cannot be diversified away.

Scenarios vs. risk-adjusted discount rates

Somehow, it seems like these are just two different ways of presenting the same idea. In the scenarios approach, you internalize the risk with in the scenario, and apply a "pure" discount rate; in the risk-adjusted discount rate approach, you try to internalize your conception of risk within the rate itself. The former is less explicit than the latter, but the result is pretty much the same.

Putting numbers to the final equation

("If we follow the position of the *Stern Review*, we can answer the question whether the government should raise taxes to fund an environmental project that yields a 1% rate of return.") Although not directly related to the discount rate question (this point is actually more germane to Section 3.2), it is worth recalling here that raising public funds involves additional costs. In particular, the marginal cost of public funds is usually estimated to be in the order of 1.2-1.4, implying that the threshold might need to be even higher than 1.4 in this example. On the other hand, if the government maintains fiscal neutrality (e.g. by lowering taxes elsewhere), these numbers will change. The net effect will depend on the marginal efficiency of the taxes that are reduced.)

Declining discount rates

The paper focuses on one reason for declining discount rates (uncertainty in the discount rate itself through time). However, there are at least three other possible reasons:

Uncertainty about future economic conditions – i.e. if the future is increasingly uncertain with time, and people's willingness to save increases with income risk, a declining discount rate will be optimal.
Heterogeneity in future preferences – i.e. if the "weight" of those with low discount rates increases through time.
Inter/intra-generational equity and potential compensation -- some environmental problems are effectively "bargains across time and space" (climate change is the obvious example). But the "weight" of some of the negotiators in arriving at that bargain is less than it is for others (e.g. people in developing countries; people unborn) is less than others. Recall that the standard application of SCBA assumes that winners can compensate losers (i.e. the Kaldor-Hicks criterion). This makes sense most of the time. For example, if net social benefits from building Heathrow Runway 5 are positive, this should be done, and the "local losers" should be compensated – assuming they have a recognized right to avoiding nuisance). But arguably, we do not have appropriate mechanisms to compensate citizens of developing countries for inaction in the area of climate change.

That said, although we understand the "environmental economics" reasoning for declining discount rates, we also recognize that this debate remains unsettled within the economic community. For the record, Pearce seemed at first to argue for a declining discount rate, but then he pulled away from that conclusion, and did not end up favouring one approach or the

other. He points in particular to the problem of time-inconsistency, and how it tends to negate the arguments that support a declining rate.

4.5 Integration

Introduction

As already stated, we didn't think the Athena/Eukrates discussion was very helpful, and would suggest that you make the points you are trying to make in a different way. For one thing, the tone of the discussion here seems inconsistent with the rest of the paper. For another, the Minister seems to have already decided that a policy-change is "necessary", and is using the SCBA approach to justify her position ex post. We think it would make more sense to argue in favour of first observing that an environmental problem exists, then doing an (SBCA) assessment of various policy options, and then (based on this assessment) deciding on whether or not to change the policy – and, if so, how.

We would also have preferred more political economy discussion in this part of the paper. Why is SCBA not more widely used? How might it find its "rightful place" in the policy cycle? In this regard, you might refer to Chapter 19 in the Pearce book, where many of these questions are directly addressed.

Typical characteristics of environmental problems

We accept the three basic elements indicated here that distinguish environmental problems from other policy issues. However:

On the "stakeholder landscape" issue, the key point is that we need to involve many stakeholders in the process because it is efficient to do so. Without effective participation, inappropriate roadblocks to efficient solutions may emerge, leading to sub-optimal design and implementation of policy.

On the "public goods" issue, a few points to make (relative to the current text) are that: (i) public goods can become marketed goods (via such tools as tradable permits). Soil has both "public" and "private" good characteristics, but so do air and water. (ii) Developing policy for all economic goods (both public and private) involves "ethical and political discussions".

On the "long-term" issue: (i) One (minor) point is that energy security is not an environmental problem. (ii) But a more important comment is that the text should acknowledge the time problem (without concluding that governments cannot decide about the long-term – which is a bit condescending to governments), but say that the discount rate discussion (see earlier section) is one way around this problem. In other words, the tone here should be positive/optimistic, rather than negative/defeatist. (iii) On the other hand, it is probably best not to give the impression that low discount rates will always lead to environmental benefits. Low discount rates will also lead to project approvals where the economic benefits only emerge over long periods of time (e.g. road construction). (iv) The subject of this paper is SCBA. In turn, SCBA can (and often does) incorporate long-term issues related to sensitivity analyses, risk, uncertainty, etc. Instead of introducing new approaches here (scenario methods; horizon scanning), why not put the long-term issue into an SCBA context, and leave it at that? (v) Another general comment here: It is true that not all political decisions will (or should) be based on rational analysis. However, it seems incorrect to move from that statement to the view that no rational analysis is needed as input to the decision-making process. If we believe

in the latter perspective, SCBA analysis is not needed at all. But we do not believe in the latter view – we think we need more rational analysis in policy-making; not less.

All of the sub-questions outlined in this part of the text seem unrelated to the issue of what assessment methodology should be adopted. They also seem to be aimed at "political economy" problems in their most abstract forms. Political economy issues are important here, but primarily in terms of the distributive and competitiveness consequences of proposed policies. One of the key issues missing from the VROM paper's discussion of SCBA to this point is that there has been little mention of these distributive issues.

One key question is "should we give more weight to impacts on lower income people, on the grounds that their marginal utility of income is higher than it is for higher income people?" Pearce seems to say that the costs of this approach probably outweigh its benefits – but suggests that a useful way forward may be to at least calculate the implicit weights in a given SCBA. Also, he feels that SCBAs should make explicit the actual distribution of costs and benefits in the presentation.

Hard facts and soft knowledge? Value–laden knowledge in environmental policy making

We accept that "analysts will measure" and "politicians will weight". But the key point is that, in order to "weigh intelligently", politicians need analysis based on interpreted facts. "Interpreted facts", in turn, are not the same thing as "negotiated knowledge". The latter implies some form of "horse-trading around the truth" – a concept that is antithetical to "good" SCBA analysis. There seems to be a recurrent bias in this part of the paper against SCBA – based on the perspective that "only Minister's views count". This seems an odd perspective, given all that has been said in earlier parts of the paper.

There also seems to be a perspective that (i) governments are not capable of thinking ahead; and (ii) they are somehow "mesmerised" by hard numbers, and unable to think for themselves about these numbers. ("However, hard facts, symbolized by concrete numbers seem to be extremely attractive for politicians and the media. In addition, SCBAs rely to a certain extent on the availability of "hard facts", a resource that is often scarce in dealing with complex societal issues"). We would not agree with either of these perspectives.

Building a joint knowledge base

Although we recognize the need to understand that environmental issues are important to a wide range of stakeholders, we think it goes too far to imply (as this section does) that everything in the SCBA analysis has to involve all actors at all stages. Joint Fact-finding can be very time-consuming and very costly. More importantly, it can become an excuse for inaction. We would therefore not agree that every step along the way has to be negotiated ex ante with all actors.

There is no reason why an SCBA cannot include a discussion of "soft knowledge" that is relevant to the policy decision. There seems to be a view here that SCBA is "obsessed with hard numbers" – again, not a view we would accept.

The choice of the method: 'to SCBA or not to SCBA?'

We would fully agree that more work needs to be done to "sell" SCBA to a sceptical public (and to sceptical Ministers). However, it should be noted that:

We believe that SCBA ***should*** be routinely undertaken in key policy analysis contexts (but only where it is likely to be efficient in itself), and we have said so in our emerging *Frame-*

work for Effective and Efficient Environment Policies (cf. "This implies the need to assess, on a regular basis, the costs and benefits of objectives that are set for environmental policy. Despite the analytical difficulties in doing so, part of this process will involve quantifying how much the public-at-large value potential changes in environmental quality").

It is also worth mentioning here that, by not attempting to place a monetary value on environmental assets, the effective result is that society gives these assets ***no value at all***. – hardly an appropriate result, and not a very valuable contribution to the policy debate from the analytical community.

All of the problems associated with SCBA also apply to other approaches to assessment (in one way or the other), so it isn't obvious why these are particularly cogent reasons for not doing SCBA.

As Pearce points out, there are many analytical approaches available. It therefore is not clear why the VROM paper keeps returning to the MCA option (see earlier comments).

There is no inherent conflict between the precautionary principle and SCBA – a point made eloquently earlier in the paper (cf. the chapter on discounting). And we are especially uncertain about discursive methodologies – methodologies that promise gridlock in the policy process.

The distinction between "private" and "collective" preferences needs to be made clearer in this section. From our perspective, individual (private?) WTPs are simply summed along the route toward a total (collective?) WTP for a given policy option. If necessary, this figure can then be weighted according to whatever criterion in seen to be useful (e.g. income weights).

("Some of the criticism on the use of SCBAs is not pointed at the method as such, but at its use in a situation in which another method would be more adequate. Differentiation is important: The fact that cars and planes are both means of transportation does not mean that a car can fly.") This seems to be saying that (i) SCBA may not be appropriate to all circumstances, and (ii) other methods may work better in some contexts. We would generally agree, but would also suggest that SCBA is likely to be more appropriate, more often, than most other options. We also note that the VROM paper doesn't actually offer any comparison of SCBA to other approaches (except for MCA). Because this comparison is not made, it isn't clear why this point is being made in the text.

The reference at the end of this section to Vining and Boardman also seems odd. What "meta-choice" decision is being referred to here? "Four types" of what?

For the record, Pearce *et al.* compares the pros and cons of CBA with a wide range of other decision-making approaches (EIA, LCA, CEA, SEA, RA, CRA, RBA, RRA, and MCA). They do not conclude that any approach is always more appropriate, implying that he thinks each has a positive role to play in some circumstances.

SCBAs and Environmental Impact Reports

The differences cited here between SCBA and EIA seem rather arbitrary – and depend more on the particular definitions that are adopted. As the text points out, the differences can be largely removed if the scope, objectives, etc. of the two approaches are aligned. For example, there is no reason why an SCBA could not be sent for comment to "all" stakeholders", obviating the "for whom" problem that is alluded to here. Overall, it wasn't clear to us where this text was actually heading.

Combining SCBA, MCA, and deliberation

This entire section seemed odd to us. For example, what is a "participative form of SCBA"? In what sense would SCBA become an "input to MCA"? Why does the paper think that it would be easier to involve stakeholders in an MCA process than in an SCBA one?

Normative Assumptions

First, a few general thoughts: (i) SCBAs are at least as transparent as MCAs; (ii) making SCBA analysis "more acceptable" is not the same thing as making it "more realistic"; (iii) as previously mentioned, MCA analysis doesn't deal with the discounting problem at all; and (iv) we would not agree that the choice of a discount rate is fundamentally a political decision.

But perhaps the most important point to make here is that, yes, there are problems with normative valuations in SCBA. However, the best way around these problems is not to "subsume" these problems within a political decision-maker's own normative construct, but to make the distributive and competitiveness consequences of these assumptions clear in the context of the SCBA analysis. This means that we should be explicit about whatever normative weights we are using, and we should usually also be applying some sensitivity analysis to those weights—to help us better understand the policy consequences if we happen to be very wrong in our assumptions.

Conclusions

"Presentation" is definitely an important issue. However, we would not agree that SCBA is "all about numbers", as is implied here. There is plenty of scope in SCBA analysis for "sensitivity to normative realities". The problem isn't usually that these issues can not be dealt with in SCBA – the problem is more likely to be that SCBA makes the assumptions (and their consequences) transparent – which is something many politicians unfortunately tend to shy away from.

5. Impressions of the workshops held on the International SCBA Conference on the 17th of January in The Hague

5.1 Introduction

At the SCBA conference three keynote speeches, afternoon speeches and two workshops were held. The intention of the workshops was to receive some feedback on some topics and conclusions in the draft-version of the RMNO-report. In the morning the discussions focused on the issues of valuation and discounting. In the afternoon session the role of SCBA in decision making was discussed. The 100 participants at the workshops were economists, other scientists, policy makers and representatives of private and public research institutes, private sector organisations and governmental organisations. This heterogeneity of the discussion groups was challenging. In this impression of the workshops first the topic of valuation is addressed. Next a short summary is presented of the discussions on discounting. Finally the role of SCBAs in the process of decision making is discussed.

5.2 Valuation and the use of Contingent Valuation Method (CVM) as preferred method to address non-use values.

There are many different valuation techniques. The report of the RMNO addresses some of those techniques but certainly not all techniques. Some remarks in general are:

The choice of the valuation technique should be highly dependent on the kind of issues and the kind of decision making that you are providing information for. For instance there are conditions under which revealed preference methods are better then CVM but CVM has the advantage that it may produce sometimes figures when other methods fail;
The application of different techniques will lead to different numbers. Therefore the choice of the technique is important;
It is important to be transparent about the choice and the motivation of the choice.

Some participants put forward the question if it is always necessary to monetise anyway. It is possible that you will be satisfied with an analysis without monetary values? Besides, is it possible to address a monetary value to everything? How to attach a price, a monetary value to things with an impact on a very large scale like for instance global climate change? Sometimes you can also loose information when you try to express everything in just one final number. A difference was made between the ethical discussion about applying the method or not and the methodological discussion about the content of the method and the weak points in a methodological sense. The key point of the ethical discussion finally is: do you accept the valuation of non-market (environmental) goods and services?

Much discussion in the workshop focused on the methodological problems and biases of the CVM –method, such as the hypothetical bias, the information bias and the generalization and aggregation problems. It was however argued, that many of these problems and biases apply also to other methods and are not especially connected to the CVM-method. Further application of the method in a proper way can reduce the methodological problems and biases and weak spots can be mitigated by the application of additional methods where possible.

A feeling in general was that there is a need for good practices. Participants thought more focus on harmonisation and good practices is necessary and there is a need for international

corporation. A concrete advise was to learn from the experiences of IPCC. A clear warning was not to look just at the method but also to decision making process.

5.3 Discounting and discount rates

The discussion on discounting and discount rate turned out to be not easy for many participants of the conference. The problem of discounting and discount rates is a highly technical one and other participants than economists usually lack the expertise to give a real feedback on this part of the report. Some concluded that the sections in the report concerning discounting are too much detailed for non-economists.

Almost everyone agrees that communication, transparency and involvement of politicians are necessary, given the complexity of the issue. Communication should be in a language understandable for non-economists.

The discussions produced no consensus about the level of the discount rate. Safe is to choose for no differentiation. Maybe there has to be one flat low discount rate.

There is a difference between valuation and discounting. Future generations may have other preferences and we have to make some guess about that and different preferences may result in different valuations. You may have different assumptions about valuation in the future and use still the same discount rate. People (and also participants) show heterogeneous attitudes with regard to discount rates.

Trade-offs between issues (choices between alternatives) can take place within the same generation or between generations. To make trade-offs one has to know the current values and preferences and the future values and preferences that are at stake. But how can we know the future? One does not know what trade-offs might be possible in the future between resources, technology etc. There is much uncertainty about what will happen in the future and what the future preferences and values will be. How do governments handle and formulate policies and thereby take in account the interests of future generations. For some, increasing uncertainty and irreversibility can be a reason for a lower or declining discount rate for issues related to climate change or biodiversity. Others ask if a lower or declining discount rate is really necessary. Can a scenario-analysis also be a good instrument to get an idea about the effects of uncertainties in future, like for instance economic grow or economic slowdown?

Finally, many participants agree that it is necessary to open the black box and talk about the assumptions. Declining, flat low or zero is not that important, as long as the consequences are shown. There is some arguing for sensitivity-analysis in all situation: Make explicit how sensitive the results are for the choice of the main parameters.

5.4 The role of SCBAs in processes of decision making

SCBA should be well integrated in the process of decision making. If the premises for a SCBA are not discussed with stakeholders, the whole exercise might be in vain. One of the minimum requirements for an SCBA is that the stakeholders at least agree with the assumptions and framing of the problems so that the future decision will be most likely accepted by the stakeholders.

Other arguments for (more) stakeholder involvement in SCBAs are:

Stakeholder involvement is important to get opinions or facts. It can enrich the input of data and stakeholder involvement can be necessary for accurate fact-finding. Lay-people are also a kind of expert. There is, of course, a risk that people or groups are not willing to give much

information or give wrong information to influence the decision making process (strategic behaviour). A basic question is: can stakeholders compromise the data or the outcome of the SCBA and how can independency (of the scientist/researcher) be ensured?
Stakeholder involvement is necessary to understand why certain issues are important and other issues are not. Knowing how people experience issues, costs and figures in the actual situation is essential.

Counterarguments in the discussion, against involving stakeholders in the process, are mainly the time pressure, which mostly exists and the costs. Although there is a general agreement that it is time-consuming, some participants in the workshops see more advantages then disadvantages. In the end it will be easier to reach a compromise and conclusions, all interests are included and participants understand each others perspectives.

There is no agreement and clear answer on these questions. Some consider SCBA just as a decision support instrument. They do not see it as a process and the democratic decision making process is just another arena for them. I is possible to connect the arenas but this is not necessary. Some argue that an SCBA should be carried out by independent scientists or researchers, but others consider it a typical Dutch case to separate the research part of the process from the political part and the decision making process.

There is a lot of discussion about the question when stakeholders should be involved. Involvement is possible before, during or after doing an SCBA-study. There is agreement that it is mostly necessary to involve stakeholders before and after the SCBA in the decision making process. There is no agreement about the issue of stakeholder involvement during the process. In any case, stakeholders should participate when there is clearly an added value. A possible advantage is that it makes the process more transparent to them, and consequently there will be more acceptance in the end. A final remark is that there are many different stakeholder groups in society and the political arena and using different scenario's can be useful to reveal the different preferences of the stakeholder groups. Some are suggesting that it might be worth wile for the government to pay attention to the different positions and their consequences in time. One SCBA for one scenario might not be enough.

The government has to decide about the strategic setting of an SCBA. About the choice to use SCBA as an instrument in the decision making process some argue that it is a political decision and others argue that the decision about the method should be made by scientists. Other possible methods are MCA and cost-effectiveness analysis. In any case the choice has to be transparent and motivated.

Finally the question was addressed when the use of an SCBA is most effective. An SCBA may be used for policy projects with large external effects or when a policy project is of great importance for a country or province. SBCAs are considered most useful for clearly defined projects (with enough well defined elements and not too many contested issues) when a choice must be made between concrete alternatives.

Annex B-1. Conference programme

Wednesday 16 January 2008

18.30 – 20.30 Conference dinner

Welcome by Prof. dr. Roeland J. in 't Veld, Chair of RMNO

Practices of SCBA in the Netherlands: the use of quantitative decision support systems, by Mr. Harry Borghouts, Commissioner of the Queen in the Province of North-Holland, the Netherlands.

Thursday 17 January 2008

08.30-09.00	Registration
09.00-09.10	Opening by Conference Chair, **Prof. dr. Roeland J. in 't Veld**, Chair RMNO
09.10-09.30	Introduction to the RMNO report, **Prof. dr. Aart de Zeeuw**, University of Tilburg and Beijer Institute, Stockholm
09.30-09.50	Prof. dr. Michael Hoel, University of Oslo
09.50-10.10	**Prof. dr. David Ulph**, University of St. Andrews
10.10-10.30	Mr. Tom Jones, OECD
10.30-11.00	Discussion/clarifications
11.00-11.20	Coffee break
11.20-13.00	Discussion in 3-4 parallel groups: **valuation and discounting** Facilitator group 1: Prof. dr. Cees Withagen Facilitator group 2: Mr. Ben Geurts Facilitator group 3: Prof. dr. Marjan Hofkes Facilitator group 4: Prof. dr. Harmen Verbruggen
13.00-14.00	Lunch break
14.00-14.15	**Mr. Hans van der Vlist**, permanent secretary, Ministry of Housing, Spatial Planning and the Environment
14.15-14.45	Plenary: conclusions and urgent research questions on valuation and discounting
14.45-15.45	Discussion in 3-4 parallel groups: role of SCBAs in environmental decision making Facilitator group 1: Dr. Ingeborg Niestroy

	Facilitator group 2: Mr. Ben Geurts Facilitator group 3: Mr. Frans Evers Facilitator group 4: Mr. Louis Meuleman
15.45-15.55	Short tea/coffee break
15.55-16.15	Plenary: Conclusions and urgent research questions on the role of SCBAs in environmental decision making
16.15-16.30	**Prof. dr. Casper van Ewijk**, dept. director of the Netherlands Central Planning Bureau
16.30-16.45	**Mr. Stephen White**, coordinator Impact Assessment, DG Environment, European Commission
16.45-17.00	**Mr. David Gee**, head of group Science, Policy and Innovation of the European Environment Agency
17.00-17.15	Final remarks & wrap up of the conference by the chair

Annex B-2 Participants SCBA Conference 16 & 17 January 2008

Rob Aalbers	Netherlands Bureau for Economic Policy Development
Erik Akse	European Commission
Elmira Asvadi	RMNO
Martijn Beekman	National Institute for Public health and the Environment
Maarten Beer	Ministry of Transport, Public Works and Water Management
Frank Beijk	Municipality Zandvoort
Mohammed Belhaj	Swedish Environmental Research Institute
Koene Bik	Wadden Sea Council
Jelle Blaauwbroek	RMNO
Arianne de Blaeij	LEI - University of Wageningen
Jeroen Bordewijk	Member of RMNO
Harry Borghouts	Queens Commissioner for Province of Noord Holland
Mirjan Bouwman	VROMCouncil
Leendert van Bree	Netherlands Environmental Assessment Agency
Sander de Bruyn	CE Delft
Marc De Clercq	Gent University
Henri Dijkman	Ministry of Finance
Robert Engelen	Province of Limburg
Frans Evers	Member of RMNO
Casper van Ewijk	Netherlands Environmental Assessment Agency
Fokke Fennema	Staatsbosbeheer, National Forest Service in The Netherlands
David Gee	European Environment Agency
Ben Geurts	Ministry of Housing, Spatial planning and the Environment
Anne Marijke Geuzebroek	Erasmus Liga - Club of Rome
Ruth Giesen	Netherlands Environmental Assessment Agency
Anja Hagendoorn	Ministry of Agriculture, Nature and Food Quality
Coen Hanschke	Energy Research Centre of the Netherlands
Martijn van der Heide	LEI - University of Wageningen
Anneke Heinecke	AdvisoryRMNO
Paul Van den Hoek	Rijkswaterstaat
Michael Hoel	Okonomisk institutt, Olso
Marjan Hofkes	VU University Amsterdam
Yolande Holthuijzen	Louis Bolk Institute
Nico Hoogervorst	Ministry of Housing, Spatial planning and the Environment
Paul Hoogewoning	RMNO
Helena Imminga-Berends	Rainbow Advice
Theo Janssen	Ministry of Agriculture, Nature and Food Quality
Tom Jones	Organisation for Economic Co-operation and Development

Ernst John Kaars Sijpesteijn	European Studies en Projects
Dirk Kazemier	Ministry of Housing, Spatial planning and the Environment
Jeroen Klooster	Arcadis Netherlands BV
Marisa Korteland	CE Delft
Hanneke Kruize	National Institute for Public Health and the Environment
Agnieszka Markowska	Warsaw Ecological Economics Centre
Willow Martin	RMNO
Jackie McGloughlin	National University of Ireland, Maynooth
Frits von Meijenfeldt	Ministry of Economic Affairs
Ivette Meijerink	VROMCouncil
Louis Meuleman	RMNO
Brian Miller	Institute of Occupational Medicine
Remco Van der Molen	Ministry of Finance
Hans du Mortier	FOSAG
Ingeborg Niestroy	European Environment and Sustainable Development advisory Councils
Hans Nijland	Netherlands Environmental Assessment Agency
Ruud Okker	Netherlands Environmental Assessment Agency
Dirk den Ottelander	ThermPhos International BV
Jan Pieters	Ministry of Housing, Spatial planning and the Environment
Rutger Pol	Ministry of Housing, Spatial planning and the Environment
Piet Rietveld	VU University Amsterdam
Jan Roels	RIVM
Freddie Rosenberg	RIGO Research en Advies BV
Jan Rouwendal	VU University Amsterdam
Rob de Ruiter T	hermPhos International BV
Hens Runhaar	University of Utrecht
Nienke Van Schie	Erasmus University Rotterdam
Hans Schiere	Advisor/Publicist
Albert Schram	University of Maastricht
Jan Schuur	Netherlands Institute for Spatial Research
Natascha Sietaram	VOM
Roel Slootweg	ITC
Ruben Smeets	Telos
Daan van Soest	University of Tilburg
Erik Spaink	Advisor
Rosanne Stotijn	Berenschot
Ana Tsiulina	RMNO
David Ulph	University of St. Andrews, Schotland UK
Rob van der Veeren	Ministry of Transport, Public Works and Watermanagement
Roel in 't Veld	Chair of RMNO
Maik van Veldhoven	Ministry of Transport, Public Works and Watermanagement
Harmen Verbruggen	VU University Amsterdam

Nol Verster	Ecorys
Kees Vijverberg	Ministry of Housing, Spatial planning and the Environment
Elisabeth Visscher-Endeveld	Living with the Earth
Johan Visser	Knowledge Institute for Mobility
Niels Vlaanderen	Ministry of Transport, Public Works and Watermanagement
Jaap van der Vlies	TNO
Hans van der Vlist	Ministry of Housing, Spatial planning and the Environment
Herman Vollebergh	Netherlands Environmental Assessment Agency
Liesbet Vranken	Flemish Institute for Technical Research
Jan de Vries	2eco
Yuca Waarts	European Centre for Nature Conservation
Edgar Wever Msc.	RIGO Research en Advies BV
Annemarie Van Wezel	KIWA Water Research
Stephen White	European Commission
Bert de Wit	RMNO
Cees Withagen	VU University Amsterdam
Reinout Woittiez	National Institute for Public health and Environment
Dirk Wolfson	Economist
David van der Woude	Rijskwaterstaat, Ministry of Transport, Public Works and Water Man-agement
Aart de Zeeuw	University of Tilburg